BILITERACY DEVELOPMENT IN CHINESE AND ENGLISH: THE ROLES OF PHONOLOGICAL AWARENESS, MORPHOLOGICAL AWARENESS AND ORTHOGRAPHIC PROCESSING IN WORD-LEVEL READING AND VOCABULARY ACQUISITION

by

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A thesis submitted in conformity with the requirements for the degree of Doctor of Philosophy
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BILITERACY DEVELOPMENT IN CHINESE AND ENGLISH:  
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AWARENESS AND ORTHOGRAPHIC PROCESSING IN WORD-LEVEL READING  
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Doctor of Philosophy 2013  
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Abstract  

This thesis examined the role of metalinguistic skills in concurrent and subsequent word-level  
reading and oral vocabulary among Chinese-English bilingual children who learned Chinese as  
their heritage language and English as their societal language. While previous studies on  
biliteracy development among this group of children have mostly focused on one of the two  
languages, this thesis gave equal emphasis to both languages. The research had two general  
purposes: 1) to investigate the role of phonological awareness, morphological awareness and  
orthographic processing in predicting word-level reading and oral vocabulary in Chinese and  
English concurrently and longitudinally; and 2) to examine the cross-linguistic role of  
phonological and morphological awareness to word-level reading and vocabulary, concurrently  
and longitudinally, between Chinese and English. These goals were explored through two  
interrelated studies, using path analyses. The participants included 91 Chinese-English bilingual  
children, recruited from kindergarten and Grade 1 Chinese heritage language classes in Canada.  
They were tested twice, one year apart, on a battery of cognitive and literacy measures in  
Chinese and English.
Findings of Study 1 on within-language relationships indicated that, for word-level reading, all three metalinguistic skills were independent concurrent predictors in English, whereas only morphological awareness was predictive in Chinese. For oral vocabulary, morphological awareness was the only concurrent predictor in both languages. The longitudinal contributions of these metalinguistic skills were mostly mediated through the auto-regressors of the literacy outcomes. Findings of Study 2 on between-language relationships demonstrated that Chinese phonological awareness directly contributed to concurrent and subsequent English word reading beyond the effect of concurrent English phonological awareness. Yet, Chinese morphological awareness indirectly predicted concurrent and subsequent English oral vocabulary through concurrent English morphological awareness. Similarly, English morphological awareness only indirectly predicted concurrent and subsequent Chinese oral vocabulary.

These findings suggest that different metalinguistic skills are required for literacy development in Chinese and English. Moreover, metalinguistic skills transfer to literacy, even across two typologically distant languages, but the transfer patterns of phonological and morphological awareness to different literacy skills vary considerably. These results are discussed in light of current reading and transfer models as well as linguistic contexts of biliteracy acquisition.
I am grateful for this opportunity to express my appreciation towards many individuals who supported me in completion of this dissertation. First of all, I would like to express my greatest gratitude to my supervisor and advisor, Dr. Xi Becky Chen, for her continuous support and intellectual inspiration, and for her faith in my abilities. I was fortunate to work with Dr. Chen throughout my academic journey at OISE/UT and was always inspired by her knowledge, passion, determination and dedication.  I would also like to thank my committee member, Dr. Helene Deacon, for her insights throughout my dissertation project, particularly into research design, data analysis, and interpretations. From Helene, I have learned to be a serious researcher and keep seeking the most scientific method in every step of my investigation. A special thank you also goes to Dr. Esther Geva for her timely guidance and feedback for both my dissertation and career decisions. I would also like to thank Dr. Rena Helms-Park and Dr. Joan Peskin for serving in my Final Oral Exam committee. As well, I was honored to have Dr. Catherine McBride-Change as my external examiner. Dr. McBride-Chang’s constructive feedback helped me greatly improve the interpretation and clarity of my dissertation.

I’d like to express my appreciation towards my former and current colleagues at OISE/UT: Gloria, Fataneh, Katie, Heidi, Adrian, Karen, and Marshid. Their friendship and support have always warmed my heart, and helped me realize that I was not alone on the long journey towards where we all dreamed to be.  Thanks to my friends, Jing, Jing-Ping, Jian, Shan, Jingshun, Naxin, and Qiang, for all of the fresh ideas and resources that I needed most to succeed in my doctoral study, and my research and life in academia. Thanks to all the research assistants who had been involved in this dissertation project in one way or another: Yuehan, Michelle,
Cuilin, Minjie, Eileen, Baibing, Helen, Maria, Eunice, Victoria, James, and Chuan. Great appreciation also goes to the children, parents, and teachers who participated in this study.

I wish to thank my parents for their unconditional love, belief and encouragement and my husband for his constant faith in and commitment to me, and for his help, inspiration and sacrifice that he made available to me during the years that I have been pursuing my dreams.

Finally, I would like to thank my two children for giving me the most beautiful smiles and sweetest kisses when I was tired, frustrated, and sometime lost in the process of this project, and for keeping my life balanced with laughter, silly questions, and imagination.
Dedication

To April and Ryan, with love

To all Chinese-Canadian children,

who are acquiring literacy in Chinese and English
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CHAPTER 1. INTRODUCTION

Rapid globalization imposes new demands for more professionals with “cross-cultural competence”, who are able to comfortably and fluently navigate across cultures and languages (Zhao, 2009, p. 173). Promoting bilingualism and multilingualism, therefore, has wide-ranging and profound educational, societal, as well as economic implications. This thesis focuses on the issue of bilingual/biliteracy development of minority children in Canada, who are exposed to and use a home language different from English and French, the societal languages. These children have a great potential to develop the cross-cultural competence highly desired by our society as they possess accessible resources of the first language (L1) from home and the second language (L2) from school. For them, being bilingual has many other benefits, including more cognitive capacity (Adesope, Lavin, Thompson, & Ungerleider, 2010; Bialystok, 2001), stronger ethnic identity (Lawson & Sachdev, 2004), closer child-and-family relations (Cho, Cho, & Tse, 1997; Wong-Fillmore, 1991), and more flexible career mobility (Krashen, 1998).

Despite its importance, supporting bilingual development among language minority children is no easy job. On the one hand, loss of heritage language or L1 has been repeatedly documented for these children upon formal schooling in L2 (Kouritzin, 1999; Wong-Fillmore, 1991). On the other hand, researchers and educators are constantly concerned about delayed school language or L2 development in these children. For example, research has shown a persistent gap in English vocabulary knowledge between English language learners (ELLs) and monolingual English-speakers throughout the elementary school years (Carlo et al., 2004; Jean & Geva, 2009). To conquer the difficulties, researchers and educators continuously sought solutions from educational, linguistic, and psychological perspectives. One idea emerging from
the existing literature is that children need to develop reading abilities in order to truly support and sustain high levels of linguistic competence in the language under acquisition. This applies not only to the school language (Stanovich, 1986), but also to the L1 (Cho & Krashen, 2000; Cho, Shin, & Krashen, 2004; Tse, 2001, 2001). In recent decades, an increasing amount of research has examined reading development in language minority children, yet most research has restricted its attention to either L1 or L2 in any given study (Oller, Jarmulowicz, Pearson, & Cobo-Lewis, 2011). This issue is particularly pronounced in the investigation of Chinese-English bilingual children who learn Chinese as a heritage language and English as the societal language. The lack of a complete picture for L1 and L2 development prevents us from understanding Chinese-English bilingual children as a whole. To address this gap, this thesis placed equal emphasis on L1 and L2 when investigating literacy development in young Chinese-English-speaking children whose parents were first generation immigrants from a Chinese-speaking country or region.

Research on monolingual reading development has suggested that cognitive and metalinguistic factors are key players in young children’s ability to acquire early literacy skills (McGrew, Flanagan, & Keith, 1997; Tunmer, Herriman, & Nesdale, 1988). Several metalinguistic skills stand out as important predictors of early literacy skills across languages for monolingual children, including phonological awareness (e.g., Adams, 1990; Bradley & Bryant, 1983; Ho & Bryant, 1997a), morphological awareness (e.g., Carlisle & Nomanbhoy, 1993; Deacon & Kirby, 2004; Mahony, Singson, & Mann, 2000; McBride-Chang, Wagner, Muse, Chow, & Shu, 2005; Singson, Mahony, & Mann, 2000), and orthographic processing (Barker, Torgesen, & Wagner, 1992; Cunningham & Stanovich, 1990; Ho, Chan, Lee, Tsang, & Luan, 2004; Stanovich & West, 1989).
Phonological awareness is defined as sensitivity to sound structures of a spoken language; morphological awareness refers to a learner’s ability to reflect on and manipulate the meaning units in spoken words; orthographic processing represents children’s sensitivity to the legality of visual patterns in writing. Reading has been theorized as an interactive process of phonology, semantics, and orthography (Plaut, McClelland, Seidenberg, & Patterson, 1996; Seidenberg & McClelland, 1989), and therefore may be uniquely dependent on phonological awareness, morphological awareness and orthographic processing. Research on monolingual children has indeed suggested that phonological awareness, morphological awareness and orthographic processing are three interrelated yet unique underlying skills involved in processing sound, meaning and print in word-level reading (e.g., Deacon, in press; Roman, Kirby, Parrila, Wade-Woolley, & Deacon, 2009). Based on the findings from monolinguals, this thesis examined independent within- and between-language contributions of these three metalinguistic skills to concurrent and longitudinal word-level reading and oral vocabulary in Chinese and English in a group of young bilingual children who learned Chinese as their heritage language and English as their societal language. It consists of two empirical studies. The first study compared the independent within-language contributions of the three metalinguistic constructs to word-level reading and oral vocabulary in Chinese and in English to understand whether there are similar or dissimilar underlying cognitive demands of learning to read two typologically different languages. The second study investigated the concurrent and longitudinal cross-linguistic contributions of phonological awareness and morphological awareness to word-level reading and oral vocabulary between Chinese and English, with the aim of understanding whether and to what extent metalinguistic skills developed in children’s L1 contribute to concurrent and subsequent literacy skills in L2, and vice versa. This is one of the first studies to
comprehensively examine the independent within and cross-linguistic role of phonological awareness, morphological awareness and orthographic processing in predicting word-reading and oral vocabulary among Chinese-English bilingual children in an English dominant language environment.

In what follows, I will first discuss the rationale of the two studies in Chapters 2 and 3. Specifically, Chapter 2 provides an overview of the characteristics of Chinese and English phonological, morphological and orthographic structures, a review of relevant theories in vocabulary and reading development in different languages and writing systems, in particular English and Chinese, and a summary of empirical evidence on independent contributions of phonological awareness, morphological awareness and orthographic processing to reading and vocabulary in each language. Chapter 3 further offers an examination of theoretical frameworks and empirical evidence pertinent to cross-linguistic transfer of metalinguistic skills to language and literacy outcomes. Chapter 4 outlines the organization and research questions of the thesis. In Chapter 5, a detailed description of the method is presented, including the characteristics of participants and the specification of measures and testing procedures. The results and discussion of Study 1 and Study 2 are reported in Chapters 6 and 7, respectively. The last chapter is a general discussion of the findings with regard to their theoretical, empirical, and educational implications.
CHAPTER 2. THE ROLE OF METALINGUISTIC SKILLS IN WORD-LEVEL READING AND ORAL VOCABULARY WITHIN LANGUAGES

According to a “simple view of reading”, successfully comprehending texts requires two equally important fundamental skills: 1) decoding (or word reading), the ability to map words to oral language to derive meaning, and 2) linguistic comprehension, the ability to understand and interpret oral information in sentence and discourse (Gough & Tunmer, 1986, 1986; Hoover & Gough, 1990). The cardinal roles of decoding and linguistic comprehension in text comprehension have been validated through various empirical studies (e.g., Georgiou, Das, & Hayward, 2009; Savage, 2001). The simple view of reading provides a pivotal framework in which to evaluate the early literacy development of young children. That is, to predict future success in reading comprehension, a sound base of both decoding skills and linguistic comprehension abilities needs to be established in young children. In light of this rationale, the present research focused on two aspects of literacy outcomes, word-level reading and oral vocabulary (as an index for linguistic comprehension as operationalised in previous research; Adlof, Catts, & Little, 2006), in understanding biliteracy development of young Chinese-English bilingual children.

Understanding biliteracy development first requires an understanding of reading processes in each of the two languages under acquisition. Reading processes across different languages involve universal behaviours of mapping written symbols to oral language (e.g., Perfetti, Liu, & Tan, 2002), yet different writing systems utilize different sets of principles to define the basic orthographic units and their relationships to language units (Perfetti et al., 2002; Perfetti et al., 2007). To understand whether there are similar or different cognitive demands in
acquiring vocabulary and word reading skills in Chinese-English bilingual children, the present research examined the independent contributions of phonological awareness, morphological awareness, and orthographic processing to word-level reading and oral vocabulary knowledge.

**Phonological Awareness in English and Chinese**

**What is phonological awareness?**

Phonological awareness refers to the ability to “recognize, identify, or manipulate any phonological unit within a word” (Ziegler & Goswami, 2005, p. 4), and can be measured at a syllable, onset-rime, or phoneme level (Høien, Lundberg, Stanovich, & Bjaalid, 1995; Treiman & Zukowski, 1991). Across languages, the sequence of acquiring different levels of phonological awareness always progresses from large to small phonological units, e.g., from syllables to phonemes (Anthony & Lonigan, 2004; Cossu, Shankweiler, Liberman, Katz, & Tola, 1988; Demont & Gombert, 1996; Durgunoğlu & Öney, 1999; Harris & Giannouli, 1999; Ho & Bryant, 1997b; Liberman, Shankweiler, Fischer, & Carter, 1974; Shu, Peng, & McBride-Chang, 2008; Ziegler & Goswami, 2005). The developmental onset of phonological awareness at different levels, however, varies as a function of the phonological complexity in a specific language (Cossu et al., 1988; Durgunoğlu & Öney, 1999; Ho & Bryant, 1997b; Share, 2008; Shu et al., 2008; Ziegler & Goswami, 2005). Taking English and Chinese as an example of comparison, Chinese children develop syllable-level awareness around the same age as English children, yet their development of rime- and phoneme-level awareness lags behind (Ho & Bryant, 1997a). This is attributed to the fact that Chinese has a simpler phonological structure than English (see the comparison of a syllable structure between Chinese and English in Table 1).
Table 1
Comparison of English and Chinese Syllable Structure.

<table>
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<tr>
<th>Syllable Structure</th>
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<th>Chinese</th>
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<td>Syllable</td>
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</tr>
<tr>
<td>Onset-Rime</td>
<td>cl</td>
<td>làng</td>
</tr>
<tr>
<td>Nucleus-Coda</td>
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<td>ī</td>
</tr>
<tr>
<td>Phonemes</td>
<td>n</td>
<td>nch</td>
</tr>
<tr>
<td></td>
<td>c</td>
<td>ch</td>
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In English, a word can be divided into syllables, onset-rime, and further into phonemes. Some English syllables contain consonant clusters (two or more combined consonants in a syllable), e.g., CVCCC in *texts*, CCCVC in *split*, and CCVCCCCC in *twelfths*. Such complexity results in a large number of possible combinations of letter strings, and therefore, several thousand syllables in spoken English. In contrast, Chinese has a simpler phonological structure. The basic speech units of Chinese are syllables. A syllable in Mandarin Chinese (hereafter referred to as Chinese) can only be formed by four types of structures: V, VC, CV and CVC. No consonant clusters (two or more consonants combined) exist in Chinese. Unlike English, a Chinese syllable is usually divided into an onset (the initial consonant, which can be missing in a Chinese syllable) and a rime (the rest of a syllable after the onset), but not to the phoneme level. Chinese has 22 onsets and 37 rimes (Li & Thompson, 1981). One of the consequences brought about by such simple phonological structures and a limited number of onsets and rimes is that there are only about 400 syllables in Chinese (DeFrancis, 1984; Taylor & Taylor, 1995). Uniquely, the Chinese rime includes a suprasegmental feature, tone. There are four tonal
contours in Mandarin Chinese, i.e., level high, rising, fall-rise, and falling, marked on top of a vowel in a syllable in Pinyin writing as in bā, bà, bǎ, and bà, respectively. A tone syllable is lexically dependent; that is, a change of tone results in a change of meaning. For example, bā, bà, bǎ, and bà, depending on the context, may mean “eight”, “pull”, “target”, and “dad”, respectively. With the consideration of tone variations, the number of syllables amounts to over 1,300 (Taylor & Taylor, 1995), yet it is still a lot fewer than English.

In light of Antony and Lonigan’s suggestion (2004) that “children’s sensitivity to different linguistic units seems best conceptualized as a single underlying ability” (p.43), the current thesis employed parallel English and Chinese phonological awareness measures that holistically tap onto children’s phonological sensitivity toward different linguistic units. Specifically, the English phonological measure assessed children’s syllable and phoneme awareness, and the Chinese phonological awareness measure assessed syllable and onset-rime awareness (given that rimes are not usually further divided into phonemes in Chinese).

The role of phonological awareness in word-level reading and oral vocabulary

In the past several decades, there has been compelling evidence that phonological awareness is the primary mechanism underlying literacy development in alphabetic languages (Adams, 1990; Bradley & Bryant, 1983; Bryant, MacLean, Bradley, & Crossland, 1990; Stanovich, 1986, 1992; Wagner & Torgesen, 1987). The central role of phonological awareness in literacy development lies in its support for children’s word-level reading abilities. To learn to read an alphabetic language, “children must at some point discover the alphabetic principle: that units of print map onto units of sound…some level of explicit phonemic awareness is required for the acquisition of spelling-to-sound knowledge that supports independent decoding” (Stanovich, 1986, p. 363). Research has shown that individual differences in phonological
awareness predict variance in word-level reading skills concurrently (e.g., Wagner & Torgesen, 1987) and longitudinally (e.g., Bradley & Bryant, 1983; Bryant, MacLean, Bradley, & Crossland, 1990). Research with English speakers has shown that the concurrent and longitudinal prediction remains even after the variance accounted for by nonverbal intelligence, vocabulary, memory, and SES is statistically controlled (e.g., Bryant et al., 1990; Wagner, Torgesen, & Rashotte, 1994). Most convincingly, the causal relationship between phonological awareness and reading has been demonstrated by well-designed intervention studies (e.g., Bradley & Bryant, 1983; Byrne & Fielding-Barnsley, 1995; Hatcher, Hulme, & Ellis, 1994; Uhry & Shepherd, 1993).

An increasing number of studies in recent years have looked into the association between phonological awareness and reading in Chinese (e.g., Ho & Bryant, 1997a; Hu & Catts, 1998; McBride-Chang & Kail, 2002; Siok & Fletcher, 2001). A correlation between phonological awareness and word reading has been consistently established in Chinese (e.g., Ho & Bryant, 1997a; Hu & Catts, 1998; McBride-Chang & Kail, 2002; Siok & Fletcher, 2001). More importantly, the unique prediction of phonological awareness to Chinese character reading survives after age, nonverbal intelligence, retrieval speed, memory, and/or visual skills are statistically controlled (e.g., McBride-Chang & Ho, 2000; McBride-Chang & Kail, 2002), and is even sustained over time (e.g., Chow, McBride-Chang, & Burgess, 2005). Cross-cultural studies with parallel designs across English and Chinese further suggest that the role of phonological awareness in initial reading development is universal across alphabetic and non-alphabetic languages (e.g., McBride-Chang, Bialystok, Chong, & Li, 2004; McBride-Chang & Kail, 2002).

The findings of the phonological-awareness-to-reading relationship in Chinese were based on a variety of samples, including children from Mainland China (e.g., Siok & Fletcher,
2001), Taiwai (e.g., Hu & Catts, 1998), and Hong Kong (Ho & Bryant, 1997; McBride-Chang & Ho, 2000). Chinese children in these regions are taught reading differently. Children from Mainland China are taught simplified Chinese characters with the support of Pinyin, a Romanized phonetic script that decodes pronunciation of characters. For instance, the character 马 means ‘horse’, and is decoded in Pinyin as mà. Children from Taiwan learn to read traditional Chinese with support of another phonetic script, Zhuyin Fuhao, which is composed of subsyllabic segments. For example, ‘horse’ is written as 马 in traditional Chinese and decoded as ㄇㄚ in Zhuyin Fuhao. Children from Hong Kong, however, learn traditional Chinese completely through a look-and-say method. Therefore, the findings of associations between phonological awareness and reading seem to suggest that despite instructional differences, learning to read Chinese, a logographic language, also requires good phonological awareness.

But why is phonological awareness important for reading Chinese? The Chinese writing system is logographic in nature. The basic orthographic units in Chinese are characters, which are composed of strokes. Strokes per se do not convey any phonological information. As a result, learning to read Chinese characters does not involve a process of sounding out and blending individual phonemes used in reading an alphabetic language. The only sub-lexical phonological information which could predict the pronunciation of a whole character is provided by the phonetic radicals of semantic-phonetic compound characters. Semantic-phonetic compound characters (approximately 80% of characters in modern Chinese) typically contain one phonetic radical that gives clues to the character’s pronunciation, and a semantic radical that provides clues to the character’s meaning. Nevertheless, the prediction from phonetic radicals to the whole character’s prediction is not always reliable: less than 40% of semantic-phonetic compound characters have phonetics that can accurately predict the pronunciation of the whole
character (Shu, Chen, Anderson, Wu, & Xuan, 2003). For example, the pronunciation of the phonetic radical 也/ye3/ is entirely different from the whole character 她 /ta1/. Taken together, phonological information available in Chinese orthography is not as transparent as that in an alphabetic language. Therefore, even though a statistical relationship between phonological awareness and word-level reading has been established through empirical investigations (e.g., Ho & Bryant, 1997a; Hu & Catts, 1998; McBride-Chang & Kail, 2002; Siok & Fletcher, 2001), one would wonder what underlying mechanism accounts for such a relationship.

It was speculated that the contribution of phonological awareness to character reading is mediated through the learning of Pinyin or Zhuyin Fuhao. Hu and Catts (1998) indirectly tested this hypothesis among 50 first-grade Taiwan children with the measures of character reading, Zhuyin Fuhao reading, and phonological awareness. The result showed that the relationship between phonological awareness and character reading remained significant after the variance in Zhuyin Fuhao reading was taken into consideration. This result, along with findings of the unique association between phonological awareness and reading in Hong Kong children who do not learn any phonetic script (Chow et al., 2005; Ho & Bryant, 1997b), jointly suggests that the connection between phonological awareness and reading does not depend on the prior learning of a transparent phonetic orthography, such as Pinyin or Zhuyin Fuhao.

Some researchers believed that phonological awareness is important in Chinese reading because of the large number of semantic-phonetic compounds in Chinese, whose phonetics provide, to some extent, phonological information about the whole words (Ho & Bryant, 1997; Hu & Catts, 1998). This hypothesis, however, has not been empirically verified. It is not very convincing given that the successful rate of using a phonetic to predict whole character pronunciation is very low, less than 40% for semantic-phonetic compounds (Shu et al., 2003).
It is possible that the relationship between phonological awareness and Chinese reading is due to phonological activation during the typical Chinese character identification process (Perfetti & Zhang, 1991, 1995; Seidenberg, 1985). Results based on adult Chinese readers’ judgement of the meanings of pairs of characters found phonological interference in the participants’ reaction times and error rates to homophonic foils (Perfetti & Zhang, 1995). This result suggested that phonological information is involved in the character identification process (Perfetti & Zhang, 1995). Such activation in Chinese may be postlexical in nature. In other words, character identification may not be mediated by phonemic processes but the identification of a printed character immediately causes the activation of its pronunciation (Perfetti & Zhang, 1991). Other researchers compared the relative time course of semantic and phonological activation in reading Chinese in several tasks, and found phonological priming effects in both character decision and naming, even though semantic effects are demonstrated to be stronger and earlier (Zhou & Marslen-Wilson, 2000). Regardless of the activation time course and the task involved, this body of research indicates that phonology may always be part of character recognition (Perfetti & Zhang, 1991, 1995; Zhou & Marslen-Wilson, 2000), in particular for characters with low frequency (Seidenberg, 1985).

Phonological awareness also plays a role in children’s vocabulary development. In fact, the relationship may be bidirectional in nature. According to the lexical restructuring model put forth by Metsala and Walley (1998), early vocabulary development is a driving force for children’s increasing understanding that the speech stream is composed of smaller phonological segments. The growing lexicon gradually allows fine-tuned comparisons between internally represented words and leads to children’s awareness of sound structures at syllable and onset-rime, as well as phoneme levels. On the other hand, advanced phonological sensitivity at the
sublexical level may help distinguish between words with similar sound units and improve the quality of phonological representation, which in turn might facilitate the acquisition of new vocabulary. Research has suggested a significant relationship between phonological awareness and vocabulary in both English (Avons, Wragg, Cupples, & Lovegrove, 1998; Bowey, 2001; Gathercole, Service, Hitch, Adams, & Martin, 1999; Gathercole, Willis, Emslie, & Baddeley, 1992; Metsala, 1999), and Chinese (Cheung et al., 2010; McBride-Chang, Cheung, Chow, Chow, & Choi, 2006; McBride-Chang, Cho, et al., 2005).

Morphological Awareness in English and Chinese

What is morphological awareness?

Morphological awareness is defined as “conscious awareness of the morphemic structure of words and their ability to reflect on and manipulate that structure” (Carlisle, 1995, p. 194). It involves both implicit and explicit understanding of morphemes, the smallest units of meaning, in a spoken language (McBride-Chang, Shu, Zhou, Wat, & Wagner, 2003). The construct of morphological awareness is multifaceted, reflecting a repertoire of sensitivity towards a variety of word formation rules (Kuo & Anderson, 2006). Across languages, complex words are formed through general rules of inflection, derivation, and compounding. The understanding of these three rules is referred to as inflectional, derivational, and compound awareness, respectively.

Inflection involves a grammar of attaching a morphemic suffix to a word stem to stay syntactically and/or semantically congruent with other words in a sentence, yet the basic meaning and grammatical category of the word stem remains unchanged. In English, verbs can be marked with inflected morphemes for tense (e.g., play → played), aspect (e.g., do → doing), and person (e.g., I finish → she finishes); nouns for number (e.g., one pencil → two pencils); pronouns for possession (e.g., her → hers); and adjectives for comparison (e.g., fast → faster). In
contrast, Chinese has very few inflectional morphemes. Suffices, such as -le, -zhe, and -guo, are used as aspect markers respectively for perfective (e.g., zuò “do” → zuòle “have done”), durative stative (e.g., zuòzhe “doing”), and experiential aspects (e.g., zuòguo “did”) (Li & Thompson, 1981). Potentializing endings, de-liao and bu-liao, are used to indicate the potential of completing a task (e.g., zuò-de-liao “can do”, zuò-bu-liao “cannot do”) (Kuo & Anderson, 2006). The suffix, -men, can be added to the end of human nouns for plural (e.g., háizi “child” → háizimen “children”) (Packard, 2000).

Derivation refers to word formation processes that change meaning or syntactic properties of word stems to generate related words through prefixing (e.g., do, redo), suffixing (e.g., thank → thankful) or infixing (not in English, but in other languages such as Tagalog, a major language used in the Philippines) (Spencer, 1991). In English, adding a prefix usually changes the meaning of a base word without altering its grammatical category (e.g., verb-to-verb: heat → preheat); whereas, adding a derivational suffix in many cases forms a word that has a different meaning as well as a different syntactic category (e.g., adjective-to-noun: sad → sadness; noun-to-adjective: operation → operational; verb-to-adjective: drink → drinkable; verb-to-noun: work → worker). Derivational suffixes are divided linguistically into two classes: neutral vs. non-neutral suffixes (Tyler & Nagy, 1989). Neutral suffixes (e.g., -ment, -ize, -ness, or -er) are usually attached, although not always, to stems what are words themselves, and generate relatively semantic transparent words; while non-neutral suffixes (e.g., -ify, -ity, -ous, or -ive) are often added to stems that are not words themselves, and tend to cause alternation of phonology (stress and vowel quality) in the stems (e.g., native /ˈneɪtɪv/, nativity /ˈneɪtɪvɪtɪ/).

English is famous for its rich derivation in word formation, which creates a sheer contrast to Chinese, a language that rarely has any derivation. What derivation is in Chinese word formation
is, in fact, a long-term debatable concept among Chinese linguists (Packard, 2000). Therefore, studies on derivation are mostly conducted in alphabetic languages such as English. There are some commonalities between inflectional and derivational morphemes. That is, they are all bound morphemes that cannot stand alone to represent meaning. But compared to inflectional morphemes, derivational morphemes in general are of a larger quantity and lower frequency, and often cause phonological alteration in word formation. Therefore, the understanding of derivation is a somewhat more complex metalinguistic awareness than that of inflection (Kuo & Anderson, 2006).

Compounding involves a process of combining two or more words to form a new meaning (e.g., daycare). The combined words could be from the same (e.g., noun + noun: sunshine) or different syntactical categories (e.g., verb + noun: spoilsport; adverb + verb: overlook). They can also be derived (e.g., note-taker) or inflected words (e.g., backstabbing). The most common compound formation in English is noun + noun, even through there could possibly be more than 20 different combinations. English compound nouns are right-headed, which means that the constituting morpheme on the right is modified by the morphemes on the left (e.g., home in homework modifies work). The right-headed rule is also shared by the Chinese compounding system. For example, the Chinese free morpheme, fáng “house”, can be used as a head and combined with other morphemes, such as lóu “storied”, pín “flat”, chú “cook”, kè “guest”, and shū “book” to form new words, lóufáng “building”, pínfáng “bungalow”, chúfáng “kitchen”, kēfáng “guest room”, and shūfáng “study room”. Many infrequent multi-morphemic words are created with high frequent morphemes (e.g., zhíshēnfēijī “helicopter” ← zhí + shēn + fēi + jī “straight + rise + fly + machine”). As a result of these simple compounding structures in word formation, Chinese is a semantically-transparent language. Even young children of 4 to 6
years old can infer the meaning of an unfamiliar word from its familiar morphological constituents (Taylor & Taylor, 1995).

Taken together, compounding is a powerful mechanism to expand vocabulary with basic morphemes, and is considered the most productive word formation process in Chinese (Packard, 2000). In comparison, English is more abundant in complex words with inflectional and derivational structures than Chinese, yet compounding structure in English is also evident. Given these characteristics, English morphological awareness measured in the current study included examinations of both derivational and compound morphological awareness, while Chinese morphological awareness measured only children’s awareness of compound structure of word formation. For example, in the English derivation awareness task, the child needed to use the target word, e.g., adventure, to produce a derived word, e.g., adventurous, in completing a sentence, e.g., The girl wants to be_______. In the English compound awareness task, for example, the child needed to make an analogy to produce a compound word based on the sentence heard, “*Early in the morning, we can see the sun rising. This is called a sunrise. At night, we might also see the moon rising. What could we call this? (moonrise).*” Chinese compound awareness in this study was measured in a similar manner to English compound awareness.

**The role of morphological awareness in word-level reading and oral vocabulary**

The role of morphological awareness in children’s literacy acquisition has attracted a large amount of attention among researchers. In English literacy development, morphological awareness, particularly in the form of inflectional and derivational awareness, has been found to be moderately correlated with word reading (e.g., Carlisle, 1995; Carlisle & Nomanbhoy, 1993; Deacon & Kirby, 2004; Fowler & Liberman, 1995; Mahony, Singson, & Mann, 2000; Singson,
Mahony, & Mann, 2000), and vocabulary knowledge (e.g., McBride-Chang, Wagner, Muse, Chow, & Shu, 2005). Converging evidence, based on different age groups and morphological measures, has shown that morphological awareness uniquely relates to word-level reading skills after controlling for phonological awareness and other general skills, such as age and nonverbal and verbal abilities (e.g., Carlisle & Nomanbhoy, 1993; Carlisle, 1995; Deacon & Kirby, 2004; Fowler & Liberman, 1995; Mahony et al., 2000; Singson et al., 2000). For example, Carlisle and Nomanbhoy (1993) demonstrated that among 6- to 9-year-old children, morphological awareness measured with a production task (e.g., Speak. *Father tells me that I am a good speaker.*) accounted for unique variance in word reading after controlling for phonological awareness. Singson et al. (2000) further showed that 8- to 12-year-old children’s knowledge of derivational suffixes, measured with a sentence cloze task (e.g., *Please don’t be so – critical, critically, criticism, criticize*), uniquely predicted decoding over and above vocabulary and phonological awareness. Similarly, Mahony et al. (2000) reported that, after controlling for vocabulary and phonological awareness, a morphological relatedness task (e.g., related: *beauty*–*beautiful*; unrelated: *general*–*generosity*) also accounted for additional variance in word reading. In addition, Fowler and Liberman (1995) reported that a morphological production task predicted real and pseudoword reading after partialing out the effects of vocabulary and age. Using a longitudinal design, Deacon and Kirby (2004) showed that morphological awareness measured at Grade 2 (age 8) with a sentence analogy task (e.g., *Peter plays at school. Peter played at school. Peter works at home.____________.* [Key: *Peter worked at home.*]) predicted pseudoword reading measured one, two and three years later, after controlling for Grade 2 pseudoword reading ability, verbal and nonverbal intelligence, and phonological awareness.
One possible reason that morphological awareness plays a crucial role in learning to read English words beyond the role of phonological awareness lies in the fact that English orthography preserves the identity of morphemes well in spelling, even though inconsistency often occurs in grapheme-phoneme mapping. For instance, a morpheme generally has constant orthographic representation in two morphologically-related words, but may undergo a phonological shift (e.g., heal–health; sign–signature). Sensitivity to such morphological structures provides an alternative yet sensible tactic to access one’s mental lexicon in word recognition so the reader does not have to rely exclusively on the sound-letter mapping principle, which is often unreliable (Carlisle, 1995; Kuo & Anderson, 2006; Nagy, Berninger, Abbott, Vaughan, & Vermeulen, 2003). Morphological awareness also provides a meaningful chunking strategy that reduces the number of units to be processed in a morphologically complex word, e.g., respectfulness. Consequently, word recognition becomes more efficient (Nagy, Berninger, & Abbott, 2006).

Studies on the role of morphological awareness in vocabulary knowledge also suggest a unique relationship beyond the contribution of general abilities and phonological awareness (e.g., McBride-Chang et al., 2005; Nagy, Berninger, & Abbott, 2006). For example, McBride-Chang et al. (2005) reported that for kindergarteners and second graders, morphological awareness measured with tasks of morpheme identification and structure awareness predicted additional variance in oral vocabulary knowledge, after partialling out the effects of phonological awareness, speeded naming and non-word repetition. Nagy et al. (2006) found that for older children in Grades 4 to 9, morphological awareness measured with suffix choice and morphological relatedness tasks contributed to reading vocabulary, even when oral non-word repetition and phonological decoding were included in the same model.
There are at least two reasons why awareness of morphological structures might contribute to vocabulary acquisition in English. First, English is composed of a large number of multi-morphemic words. According to the estimation by Nagy and Anderson (1984), approximately 60% of new words encountered by school-age children are morphologically complex, and constituent morphemes provide sufficient information for children to infer the meaning of the whole words. Access to morphemes, therefore, facilitates learning of new yet related vocabulary. Second, Nagy and Anderson (1984) also point out that “for every word a child learns, there are an average of one to three additional related words that should also be understandable to the child” (p. 304). Morphemes, in that case, serve as important links among the related words stored in mental lexicon. As a result, awareness of the links (or morphemes) may speed the retrieval process in oral production.

In comparison, morphological awareness may be more important for Chinese literacy development than for English (e.g., McBride-Chang, Cho, et al., 2005). Chinese is often labelled as a ‘morphosyllabic’ or ‘morphographic’ writing system. A Chinese morpheme maps onto a syllable in the oral language and also a character in print. The straightforward correspondence makes Chinese a unique language for research on morphological awareness (Packard, 2000). As aforementioned, the most dominant word formation in Chinese is compounding. Research on the relationship between morphological awareness and literacy development in Chinese has focused primarily on compound morphology and in general found it to be uniquely predictive of character recognition (e.g., McBride-Chang et al., 2003b; Shu et al., 2006), and vocabulary (e.g., McBride-Chang et al., 2005) over and above phonological awareness.

In addition, McBride-Chang and colleagues (2003) tested kindergarten and Grade 2 Hong Kong children’s Chinese morphological awareness with two measures: one is the Morpheme
Identification task that tapped into children’s sensitivity to homophone morphemes, and the other is the Morphological Construction task that examined children’s ability to produce compound words. Morphological Construction was moderately correlated with character reading ability in both kindergarten and Grade 2, yet Morpheme Identification only related to character reading in Grade 2. The authors did not provide further explanation regarding this difference, but it seemed that compound awareness measured by the Morphological Construction task was a more consistent correlate to character reading, even from early on. The study (McBride-Chang et al., 2003b) further reported that the combined morphological construct of Morpheme Identification and Morphological Construction uniquely predicted character reading for the combined kindergarten and Grade 2 group after controlling for age, visual skills, verbal abilities, phonological awareness, and rapid naming.

Studies further suggested that the importance of morphological awareness in Chinese reading development holds for both dyslexic and non-dyslexic children (Shu et al., 2006). Shu et al. (2006) included a Morphological Production task to measure Chinese children’s awareness of compound structure, and found this task, when compared to phonological awareness, rapid naming, and vocabulary, was the strongest consistent unique predictor of character recognition, character dictation and reading comprehension for both dyslexic and non-dyslexic Grade 5 and 6 students.

The role of morphological awareness in literacy development differs across languages (e.g., McBride-Chang, Cho, et al., 2005). For example, using structural equation modeling, McBride-Chang et al. (2005) conducted a cross-language comparison of relations among phonological awareness, morphological awareness, vocabulary, and word recognition across second graders from Beijing, Hong Kong, Korea, and United States. Cross-language differences
emerged as morphological structure awareness was more important for reading in Chinese and
Korean than for reading in English, while phonological awareness was more important for
reading in English and Korean than for reading in Chinese.

In Chinese, compound structure awareness was also uniquely predictive of vocabulary
knowledge after controlling for phonological awareness, and such unique prediction seems to be
universal across languages (e.g., McBride-Chang et al., 2005). McBride-Chang et al. (2005)
reported compound structure awareness was predictive of vocabulary knowledge in second
graders, even with phonological awareness included in the models. Such relationship was
consistent across children from Beijing, Hong Kong, Korea and the United States. Their results
seem to suggest that the unique relationship between morphological awareness and vocabulary
over and above the effect of phonological awareness is universal across languages.

**Orthographic Processing in English and Chinese**

**What is orthographic processing?**

The term orthography refers to conventions used in a writing system to represent the
sound of a language (Treiman & Cassar, 1997). Orthographic processing is a print-based skill,
involving “memory for specific visual/spelling patterns that identify individual words, or word
parts, on the printed page” (Barker et al., 1992, pp. 335–336), and in the current study, I use
orthographic processing and orthographic knowledge interchangeably to refer to the same
construct. Orthographic processing includes two levels of processing: 1) lexical level –
processing of actual spelling of particular words; 2) sub-lexical level—extracting and
recognizing permissible spelling patterns across different words (Siegel, Share, & Geva, 1995).
Lexical-level processing is assessed with tasks requiring a judgment between two phonologically
plausible alternatives (e.g., *bowl* and *bole*; Olson, Forsberg, Wise, & Rack, 1994). Recently,
more research has focused on sub-lexical processing by evaluating sensitivity to spelling legality within contrasting pseudowords (e.g., choosing the most word-like of two options: filk-filv; Siegel, Share, & Geva, 1995; vake-vayk; Conrad & McNutt, 2008). These sub-lexical measures best evaluate sensitivity to orthographic regularities, in that they are separable, at least to some extent, from the reading measures that they are often used to predict (Castles & Nation, 2006). Therefore, the present study focuses on sub-lexical processing.

Chinese orthographic processing at the sub-lexical level refers to children’s sensitivity to the positional legality of the formation. Chinese is a writing system composed of thousands of characters (e.g., 由 and 江). The smallest orthographic unit in Chinese is the stroke (e.g.,丶 and 丿). Unlike letters in alphabetic languages, a stroke does not have either pronunciation or meaning. Strokes combine to form radicals, which are important functional units (Peng, Li, & Yang, 1997; Shu & Anderson, 1999). More than 80% of characters in modern Chinese are semantic-phonetic compounds. Most semantic-phonetic compound characters consist of one semantic radical and one phonetic radical in either a left-right or top-bottom structure (Shu, Chen, Anderson, Wu, & Xuan, 2003). The semantic radical indicates the meaning of the character, while the phonetic radical represents the pronunciation, although the representation is not always reliable. For example, the semantic-phonetic compound character 清 qīng, consists of one semantic radical 氵 on the left, meaning water, and one phonetic radical 青 qīng on the right, suggesting the pronunciation qīng. In 花 huā, the semantic radical 艹 appears on the top meaning plant, and the phonetic radical 化 huà appears at the bottom, partially suggesting the sound of the character. Generally speaking, semantic radicals tend to appear on the left or top positions and phonetic radicals on the right or bottom positions, though exceptions do exist. An
estimated 200 semantic radicals and 800 phonetic radicals exist in modern Chinese (Hoosain, 1991).

**The role of orthographic processing in word-level reading**

Orthographic processing is a print-based skill and has received substantial attention in the literature with regard to its contribution to reading (see Berninger, 1994). According to the dual-route model, words can be recognized through two different approaches. One is the phonological approach in the identification of regular words based on the phoneme-grapheme correspondence; the other is the lexical approach in the recognition of exceptional/sight words through memorization of actual spelling of particular words or permissible spelling patterns across different words (Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001). With practice, words that rely on the phonological approach for recognition gradually become sight words for children and can be recognized through the lexical approach. The former approach heavily involves readers’ phonological skills, while the latter relies on orthographic knowledge. Nevertheless, phonological decoding and orthographic processing are two interdependent underlying processes in reading or learning to read, because orthographic patterns also decode phonological information.

Share’s Self-Teaching hypothesis (1995) explicitly explained such interdependence in English reading. In particular, the reader’s orthographic knowledge is acquired through the successful phonological recoding experience allowed by repeated exposure to print. In other words, initial phonological decoding abilities and print exposure are *sine qua non* for the development of orthographic knowledge. Thus, it has been asked whether orthographic knowledge is an aetiology distinct construct in reading (see Burt, 2006). Theoretically, understanding the unique contribution of orthographic processing to reading, independent of
phonological skills and print exposure, is of particular interest (e.g., Barker et al., 1992; Cunningham, Perry, & Stanovich, 2001; Cunningham & Stanovich, 1990; Stanovich, West, & Cunningham, 1991). Results emerging from empirical studies to some extent support the distinctiveness of orthographic processing in English reading beyond the contribution of age, nonverbal abilities, phonological skills and/or print exposure (e.g., Barker et al., 1992; Cunningham et al., 2001; Cunningham & Stanovich, 1990; Stanovich & West, 1989). For example, the estimated unique contribution to English word reading independent of phonological skills ranges from 7% to 10% for children (Barker et al., 1992; Cunningham & Stanovich, 1990) and about 7% for adults (Stanovich & West, 1989). When print exposure was additionally controlled, the unique contribution to English word reading dropped to about 6% for children and 4% for adults (Burt, 2006).

Notably, these studies mostly used an orthographic choice task, which taps into orthographic processing at a lexical level. For example, the participants would need to judge the correct spelling between two phonological plausible items, with one item being a non-word and the other being a real word (e.g., *bote* vs. *boat*; see Olson et al., 1994). One would argue that there could still be confounding with the reader’s familiarity to the real words in experimental items. Recently, researchers have started to measure orthographic processing at the sub-lexical level (e.g., choosing the most word-like of two options: filk-filv; Siegel, Share, & Geva, 1995; vake-vayk; Conrad & McNutt, 2008). Very limited research, however, examines the contribution of sub-lexical orthographic processing to word reading, which is a particular consideration in the present study.

Learning to read Chinese seems to make a relatively high demand on orthographic processing, given the logographic nature of the Chinese language (e.g., Ho et al., 2002, 2004,
McBride-Chang and Ho (2005) examined biliteracy development among 4-year-old kindergarteners in Hong Kong, and found orthographic processing was only uniquely predictive of Chinese character recognition beyond the effects of vocabulary, phonological awareness and spelling, but it was not as strong in English word reading. Research on Chinese dyslexic children has suggested that orthographic processing is a dominant cognitive deficit in Chinese developmental dyslexia (e.g., Ho et al., 2002, 2004, 2007). For example, Ho et al. (2007) reported that 62% children in their dyslexia sample demonstrated problematic orthographic processing abilities and were classified to be the surface subtype, while no child belonged to the phonological subtype, a category most prevalent in English developmental dyslexia (Morris et al., 1998; Stanovich, Siegel, & Gottardo, 1997).

Independent Roles of Phonological, Morphological and Orthographic Skills

Most of the studies that have been reviewed thus far focused exclusively on one of the three metalinguistic skills—phonological awareness, morphological awareness, or orthographic processing—and its relation to literacy outcomes. The findings suggest that, when examined separately, all three skills are important correlates of early literacy outcomes measured on word reading skills and/or vocabulary across English and Chinese. Some studies have also shown that in comparison to reading English, reading Chinese may rely more on morphological awareness and orthographic processing than phonological awareness (e.g., Chung et al., 2007; Ho et al., 2004, 2002; McBride-Chang, Cho, et al., 2005; McBride-Chang & Ho, 2005).

Recently, researchers have attempted to understand reading acquisition from a new angle with an emphasis on the interactive process of orthography, phonology and semantics (Plaut et al., 1996; Seidenberg & McClelland, 1989). In this view, orthography, phonology and semantics
are three interrelated aspects of reading acquisition, and the nature of the relationship between any one aspect and reading cannot be fully understood in isolation without the examination of the other two. There is, however, surprisingly little research examining the independent contribution of each of these aspects to reading within one study. One recent study empirically examined the independent influence of phonological awareness, orthographic processing and morphological awareness on early word reading among monolingual English-speaking children in Grades 1 and 3 (Deacon, in press). The results showed that each of the three variables made an independent contribution to both real and pseudoword reading. More importantly, independent contributions of phonological awareness (7-17%) to word reading were consistently larger than those of orthographic processing (5-10%) or of morphological awareness (1-2%), suggesting that phonological awareness played a more important role in English reading at the early stage of reading development.

In a similar vein, this thesis was designed to examine the independent contributions of phonological awareness, morphological awareness, and orthographic processing to word-level reading in Chinese and English for young bilingual learners. As discussed earlier, oral vocabulary is another important literacy component in developing successful reading comprehension skills (as suggested by the Simple View of Reading). Therefore, independent contributions of phonological and morphological awareness to oral vocabulary in both languages were also explored in the current research (orthographic processing is included as it is a print-based skill). Through a direct comparison of these independent contributions between Chinese and English, the thesis aimed to investigate whether the three metalinguistic skills play similar or different roles in early acquisition of literacy skills in two typologically dissimilar languages of bilingual learners. These similar and/or different roles of phonological awareness, morphological
awareness and orthographic processing in word-level reading and oral vocabulary in Chinese and English would help us understand the effects of writing system constraints and universal reading processes on early biliteracy acquisition of two typologically different languages. Beyond concurrent relationships, the thesis also investigated whether the three skills predict word-level reading and/or oral vocabulary beyond the auto-regressive controls of the literacy outcomes, one year later. The examination of this longitudinal effect is important, to identify the nature of what predicts these literacy outcomes as a result of developmental change in metalinguistic abilities (see a similar discussion in Geva & Farnia, 2012). This is one of the few studies that have examined independent contributions of the three skills to biliteracy development in a longitudinal framework. Kindergarten and Grade 1 children were chosen because they are of particular interest in our understanding of the effects of metalinguistic skills developed early in life through language and print exposure on initial literacy acquisition.
CHAPTER 3. CROSS-LANGUAGE TRANSFER

From a psycholinguistic perspective, biliteracy development among young children can be understood by two sources of influence. One concerns the processes involved in learning each of the two languages per se, an issue discussed in the previous chapter. The other involves any interaction between the learning of the two languages, the focus of the current chapter. Such interaction is often captured by the observation of cross-language relationships between learners’ L1 and L2. In the literature, a cross-language relationship is also operationally conceptualized as cross-language transfer--a central concern among L2 researchers (Koda, 2004). With a long history, investigation of transfer issues in second language learning and teaching can be dated back to the 1940s (Gass & Selinker, 1994). Its initial focus was on L2 acquisition of linguistic structures, such as phonology and grammar. Recently, serious research attention was drawn to the role of transfer in reading among second language learners or bilingual learners (e.g., Genesee, Geva, Dressler, & Kamil, 2006; Koda, 2004). However, little is known about whether and how skills transfer between two typologically different languages like English and Chinese. One goal of this thesis was to empirically test cross-language transfer in reading between English and Chinese among young bilingual learners. In the following sections, I will first discuss theoretical underpinnings of cross-language transfer and then relevant empirical investigation.

Theoretical Underpinnings of Cross-Language Transfer

The term ‘cross-linguistic transfer’ can be generally understood as a process of speakers applying knowledge from their native language/L1 to the learning of a second. Selinker (1964) once pointed out that theoretical understanding of how cross-linguistic transfer operates requires three fundamental questions to be answered: 1) What can be or actually is transferred (what is
transferable)? 2) How does language transfer occur? 3) What types of language transfer occur?

Researchers do not agree on their answers to these questions in their theorization of transfer. In one example, Dechert and Raupach (1989) presented a collection of as many as 17 different definitions adopted by various researchers, a perfect illustration of the ambiguity associated with the term. Many years later, lack of consensus still exists in transfer theories (e.g., Koda & Zehler, 2008).

There are several reasons for conceptual disagreement on what transfer actually entails in L2 learning. First, language learning is a complex process, involving specific linguistic rules and cognitive processes as well as general strategies. Differential emphasis has been placed on various aspects of the process in theoretical considerations and empirical interpretations of language transfer, ranging from linguistic forms or rules (e.g., phonology, and grammar) to cognitive/metalinguistic processes (e.g., phonological awareness).

Second, from an effect perspective, transfer can be generally understood as two opposite processes: negative vs. positive transfer. The former illustrates inhibiting effects of learners’ L1 on acquisition of L2, and is dominated by studies in light of an early model – the Contrastive Analysis Hypothesis – that deals with the use of L1 characteristics to predict errors in learning L2 phonological and grammatical systems (see Dechert & Raupach, 1989; Odlin, 1989). The latter concerns facilitating effects of L1 on L2, particularly under more recent contentions that a learner’s prior language experience helps create an essential foundation for establishing an additional linguistic system (Cummins, 2000; Genesee et al., 2006; Koda & Zehler, 2008). Empirical studies have shown that various aspects of L1 capabilities may support learning of related skills in L2, such as morphosyntax, metalinguistic awareness, communicating strategies, and pragmatics (Koda, 2004).
Third, transfer concepts have been explained within quite a few theoretical frameworks, with each emphasizing different aspects of transfer issues. These frameworks include but are not limited to the Contrastive Analysis Hypothesis (Fries, 1945; Lado, 1957), the Linguistic Interdependence Hypothesis (Cummins, 1979, 2000), a paradigm regarding underlying cognitive abilities (Geva & Ryan, 1993) and the more recently proposed Transfer Facilitation Model (Koda, 2008). The Contrastive Analysis Hypothesis (Fries, 1945; Lado, 1957) highlights the importance of considering linguistic characteristics of learners’ L1 and L2, and the necessity of comparing the two languages at a fine-tuned level when examining cross-linguistic transfer. Yet the Linguistic Interdependence Hypothesis (Cummins, 1979, 2000) incorporates the psychological and cognitive dimensions of cross-linguistic transfer, and as well considers the developmental dependence between the two languages under acquisition. The paradigm involving underlying cognitive abilities (Geva & Ryan, 1993) further looks into the specific cognitive mechanism facilitating bilingual and biliteracy development. Finally, the Transfer Facilitation Model (Koda, 2008) is specifically relevant to conceptualization of transfer in reading, through the investigation of metalinguistic abilities. Again, there are many other theoretical models accounting for the issue of transfer. These four models are highlighted here because of their particular relevance to the current thesis.

**Contrastive Analysis Hypothesis**

The general contention of the Contrastive Analysis Hypothesis (CAH) is that difficulty or ease of L2 learning can be predicted by the characteristics of the learner’s native language. (e.g., Fries, 1945; Lado, 1957). Based on this basic assumption, Fries (1945) suggested that the most efficient L2 materials are “those that are based upon a scientific description of the language to be learned, carefully compared with a parallel description of the native language of the learner”
Lado (1957) substantially enriched this hypothesis through concrete suggestions for scientific and systematic structural analysis of various aspects of language learning for learners’ L1 and L2, including phonology, grammar, vocabulary, writing systems, and even cultures (Lado, 1957). In its early version, the CAH, however, overstressed the interference of a learner’s first language in the acquisition of an additional language, and was mainly used as a predictive tool to foresee difficulties that second language learners from a particular language background would encounter in learning the second language. A contemporary version of this hypothesis considers an additional factor introduced by the L1-L2 distance, and acknowledges that both interference and facilitation may occur in language learning depending on similarities and differences between languages (see Genesee, Geva, Dressler, & Kamil, 2006; Koda, 2004). In a sense, learners tend to make errors or encounter difficulties (interference) when learning structures in a second language that differ from or are unfamiliar to them in their first language. Yet, when encountering structures that are shared by the two languages, learning becomes relatively easy (facilitation). As an example of positive transfer, Chinese-speaking English language learners find it easier to learn compounds in English because Chinese abounds with compound words (Ramirez, Chen, Geva, & Luo, 2011).

The pioneering role of the CAH in L2 research has been widely acknowledged, in that it was one of the earliest models proposed in relation to cross-language transfer. In fact, its birth marked the beginning of theoretical and empirical interest in the issue of cross-language transfer in L2 research. Meanwhile, the CAH has often been criticized for a lack of accuracy in its predictability, or inadequacy in explaining certain aspects of transfer (e.g., Gass, 1988; Genesee, Geva, Dressler, & Kamil, 2006). For instance, some researchers have found that certain errors made by the L2 learners are similar to those made by L1 speakers (Bailey, Madden, & Krashen,
1974), and therefore, L1 characteristics are not sufficient predictor of L2 outcomes. Instead, some errors are developmentally determined and hence universal for both L1 and L2 learners. Moreover, the hypothesis is criticized as largely concerning the influence of linguistic subsystems on transfer (e.g., phonological, lexical, morphological and syntactic), and thus is believed to be a framework unsuitable for elucidating cross-language relationships that are more psychological in nature (e.g., metacognitive strategies) (Genesee et al., 2006). Another limitation is that the CAH cannot explain cross-linguistic transfer that crosses domains (e.g., phonological awareness cross-linguistically related to reading, as shown in Durgunoğlu, Nagy, & Hancin-Bhatt, 1993; Gottardo, Yan, Siegel, & Wade-Woolley, 2001).

Nevertheless, one most significant contribution of the CAH lies in the fact that it brings learners’ first language into the picture of L2 learning, and in particular, accentuates the importance of systematic comparison of linguistic structures between L1 and L2. This L1-vs-L2 comparative paradigm sets a cornerstone for conceptualizing and interpreting many subsequently proposed L2 theories (e.g., language universal vs. language specific theories; Bialystok, 2007; Perfetti, 2003). This is also where the current thesis stands, in that empirical evidence of cross-language relationships may need to be interpreted with the consideration of L1 and L2 structural features in order to pinpoint what is actually transferred and why.

**The Linguistic Interdependence Hypothesis**

The Linguistic Interdependence Hypothesis (LIH; Cummins, 1979, 2000) in many ways complements the Contrastive Analysis Hypothesis by stressing the essential roles of psychological and cognitive factors in cross-language transfer, and considering other factors such as language exposure and motivation. In Cummins (1981), the LIH was formulated as follows: “To the extent that instruction in a certain language is effective in promoting proficiency in that
language, transfer of this proficiency to another language will occur, provided there is adequate exposure to that other language (either in the school or environment) and adequate motivation to learn that language (p. 29).” Unlike the CAH, which mostly concerns the inhibiting effects of L1 experiences on L2 learning, the LIH focuses more on possible cognitive benefits of learning two languages, including more flexibility in cognitive manipulation and thinking, and more advanced meta-linguistic abilities.

Moreover, unlike a unidirectional L1-to-L2 impact emphasized in the CAH, the cross-language influence postulated in the LIH is reciprocal between L1 and L2. It is further interpreted as a hypothesis that “not only predicts transfer from L1 to L2, but also from L2 to L1” (Verhoeven, 1994, p. 383). Nevertheless, such bi-directional cross-language transfer is not without constraints. As specified in the Threshold Hypothesis (another hypothesis also proposed by Cummins, 1979), minimum levels of linguistic competence in both L1 and L2 need to be attained to allow cross-language transfer to occur. In particular, Cummins (2000) strongly argues for advantages associated with maintaining high L1 proficiency in bilingual development, and states, “academic proficiency transfers across languages such that students who have developed literacy in their first language will tend to make stronger progress in acquiring literacy in their second language” (p. 173).

The LIH has also been empirically confirmed through many studies demonstrating transfer of L1 language and literacy skills to L2 literacy abilities (e.g., Abu-Rabia, 2001; Verhoeven, 1994), and gained popularity in bilingual research and education. As a result, it has fundamentally shaped conceptualization of cross-language transfer, and challenged traditional views in which being bilingual was associated with mental confusion or cognitive dysfunction. Nevertheless, it is still often criticized for lack of specificity in explaining what is actually being
transferred across languages. In Cummins’ notion, it is common underlying proficiency that is transferrable or transferred between L1 and L2; though the construct itself is vaguely defined. Genesee et al. (2006) refer to it as: “procedural knowledge that underlies language use for academic or higher order cognitive purposes and entails for example, the skills involved in defining words or elaborating ideas verbally as is often required when language is used for academic purposes” (p. 157). But still, it has been understood as a very general construct. Therefore, solely relying on the LIH is not sufficient for identifying what specific skills or abilities are transferred.

**Underlying Cognitive Abilities**

Furthering the Linguistic Interdependence Hypothesis, researchers have started to specify underlying cognitive abilities that support acquisition of both L1 and L2, to conceptually understand and empirically investigate cross-language transfer (e.g., Geva & Ryan, 1993). By far, phonological processing has been one of the mostly studied cognitive construct in this line of research. It refers to the cognitive manipulation of phonological information, and consists of three interrelated skills: phonological awareness, lexical access, and verbal working memory (Comeau, Cormier, Grandmaison, & Lacroix, 1999; Wagner et al., 1997; Wagner & Torgesen, 1987; Wagner, Torgesen, & Rashotte, 1994) that are assumed to underlie the development of word level reading skills in L1 and L2.

Phonological awareness, as defined in Chapter 2, refers to the ability to manipulate sound structures in a spoken language and is a critical component for developing literacy skills among monolingual children (Adams, 1990; Brady & Shankweiler, 1991). Lexical access (often referred to as phonological decoding) represents the proficiency of accessing the phonological representation of written information (Crowder & Wagner, 1992). It is empirically measured
with rapid automatized naming (RAN) tasks on numbers, letters, or objects. On the other hand, verbal working memory refers to the mental capacity for temporarily storing auditory information for processing and manipulation (Baddeley, 1986). Retention of phonological information in working memory through continuous repetition allows synthesis of individual speech sounds into syllables and words. There are two slightly different working memory processes captured by different measures in the studies of cross-language transfer. One emphasizes the temporary storage function of our working memory system, and is often specifically called verbal short-term memory and measured with a pseudoword repetition task (e.g., Gottardo et al., 2001; Mumtaz & Humphreys, 2001). The other concerns more of an executive capacity, which focuses on the processing rather than the storage function of working memory. Different measures are employed to tackle this construct, such as a sentence completion (e.g., Abu-Rabia, 1997) and an opposite task (e.g., Gholamain & Geva, 1999).

The cognitive processing skills defined above are generally thought to be fundamentally cognitive in nature, and form part of the underlying mechanism accounting for individual differences in language learning of both L1 and L2, or any other language (Genesee et al., 2006). Indeed, empirical studies have revealed correlations between L1 and L2 in phonological awareness (e.g., Abu-Rabia, 1997; Cisero & Royer, 1995; Gottardo, Yan, Siegel, & Wade-Woolley, 2001; Mumtaz & Humphreys, 2001), lexical access (e.g, Gholamain & Geva, 1999), verbal working memory (Abu-Rabia, 1997; Da Fontoura & Siegel, 1995; Gholamain & Geva, 1999) and short-term memory (e.g, Mumtaz & Humphreys, 2001). These cross-language relationships have been taken as evidence to explain more specifically how L1 and L2 are related.
The Transfer Facilitation Model

More recently, Koda (2008) proposed the Transfer Facilitation Model (TFM) in an attempt to explain cross-language transfer pertinent to reading development. In essence, the model highlights the potentially important role of metalinguistic awareness developed in one language in promoting reading acquisition in another, among diverse groups of second language learners. Metalinguistic awareness refers to the ability to make language forms objective and explicit through identification, analysis and manipulation (Cazden, 1974; Koda, 2008). Its significance in literacy acquisition is expounded by Koda (2008) as follows:

The significance of this ability lies in its capacity for enabling the learner to analyze words into their phonological and morphological constituents. Since learning to read entails learning to map between spoken language elements and the graphic symbols that encode those elements, metalinguistic awareness, emanating from oral-language development, substantially expedites the initial stages of reading acquisition. Therefore, systematic examinations of first-language metalinguistic contributions to second-language reading acquisition are likely to yield substantial insights into shared resources, across languages, available to second-language learners. (pp. 68-69)

Within this model, Koda (2008) defines transfer as “an automatic activation of well-established first-language competencies, triggered by second-language input” (pp.78). This contention operates under three important assumptions:

1) for transfer to occur, the competencies to be transferred must be well rehearsed – to the point of automaticity –in the first language; 2) transfer is not likely to cease at any point in second-language development; 3) transferred competencies will continuously mature through processing experience with second-language input. (pp.78-79)

In a sense, cross-language transfer has been viewed as a developing, ever changing, interplay between well-established L1 competencies, in this case metalinguisic awareness, and cumulative print exposure to L2. As such, transfer is a dynamic rather than static process.
The cross-language relationships under scrutiny in the TFM lie between metalinguistic awareness in one language and literacy outcomes in another. It concerns cross-modal effects in biliteracy development as the transferred skills under investigation are in an oral language form, while impacted abilities are in written – basically across two different language modalities. The model underscores that L1 facilitates L2 acquisition, in that metalinguistic capacity developed in L1 can be readily available and similarly functional in L2 reading development. A growing body of research has examined such cross-language cross-modal effects of metalinguistic abilities and generally supports the prediction of the TFM. For instance, a cross-language cross-modal relationship has been established between phonological skills and word reading among children who learn two typologically similar languages, such as Spanish-English (e.g., Durgunoğlu et al., 1993), and English-French (e.g., Comeau, et al., 1999), and those who learn typologically dissimilar languages, such as English and Hebrew (e.g., Wade-Woolley & Geva, 2000), or English and Chinese (e.g., M. Wang, Perfetti, & Liu, 2005). Emerging evidence has also shown that some aspects of morphological awareness, as another dimension of metalinguistic skill, may also be transferrable to reading across languages (e.g., Deacon, Wade-Woolley, & Kirby, 2007; Ramirez, Chen, Geva, & Kiefer, 2010; M. Wang, Cheng, & Chen, 2006), even though research on morphological awareness is still too limited to reveal the patterns of morphological awareness transfer as a function of subtypes and the distance of languages under acquisition.

**Integrated approach to the conceptualization of transfer in reading**

The aforementioned theoretical frameworks have jointly contributed to current conceptualizations of cross-language transfer in reading research. The joint contributions, together with evolving understanding of reading acquisition, endorse a more integrated view
towards the issue of transfer, which is also where the current thesis stands theoretically. Together, there are three emerging themes worth in-depth discussion here.

First of all, early transfer theories emphasize linguistic structures (e.g., phonology and grammar intensively examined under the Contrastive Analysis Hypothesis), while later proposed models underscore the cognitive dimensions of transfer (e.g., common underlying proficiency shared by L1 and L2 in the Linguistic Interdependence Hypothesis; working memory in the model that concerns specific underlying cognitive abilities). Recent conceptualizations of transfer in reading, on the other hand, call for a more inclusive theorization that involves examination of both linguistic and cognitive aspects as well as learning strategies and problem-solving skills (e.g., August & Shanahan, 2006; Genesee, Geva, Dressler, & Kamil, 2006). These reservoirs of knowledge, skills and abilities are conceptualized as resources that serve second language learning and use (Genesee et al., 2006). The investigative focus, therefore, is now more on the identification of the resources developed in L1 and readily available to learners when acquiring L2 language and literacy skills, rather than prototypically categorizing cross-language effects as either negative or positive (Genesee et al., 2006; Koda, 2008).

Secondly, investigation of cross-language transfer in reading has been pushed forward by a component approach endorsed by current understanding of what reading processes entail. In an old view, reading was considered from a holistic perspective as a psycholinguistic guessing game (Goodman, 1967) or as a top-down process relying less on graphic cues (Smith, 1971). Converging evidence, however, has suggested that a bottom-up process is also involved, and in fact is fundamental in reading (Perfetti, 1985; Rayner, 1998; Stanovich, 1980). In light of the new understanding that values both word-level and higher-level processes, reading is regarded as a complex mental process consisting of separated yet interrelated individual operations, or
subcomponents (e.g., Carr & Levy, 1990). Reading at the word level is understood as an interactive process of accessing phonology, semantics, and orthography (Plaut et al., 1996; Seidenberg & McClelland, 1989). As such, phonological, morphological, and orthographic skills are three component skills important for reading development. Influenced by this componental view, examination of transfer has focused on cross-language relationships of component skills between the first and second languages and also cross-modal contributions of these skills in one language to reading in the other (Koda, 2008). This cross-linguistic cross-modal approach will also enable us to specify what skills are actually transferred in our investigation and theorization.

Last but not the least, distance, or the degree of similarity and dissimilarity, between the two languages under acquisition is a critical factor for interpreting cross-language transfer. The idea has long existed in literature, as the early model of the Contrastive Analysis Hypothesis (Lado, 1957) uses the L1-to-L2 distance to predict difficulty or ease of acquiring L2 linguistic structures among learners of a specific L1 background. Indeed, research has shown that cross-language similarities facilitate L2 learning while differences inhibit the acquisition. For example, vocabulary acquisition is supported when first and second language share cognates, or words with similar forms and meanings (Hancin-Bhatt & Nagy, 1994; Nagy, García, Durgunoğlu, & Hancin-Bhatt, 1993); in contrast, students’ ability to infer unfamiliar vocabulary words is negatively affected when the target and native languages differ considerably (Saville-Troike, 1984). Current investigation of transfer, as mentioned at an earlier point, has been largely influenced by the component approach. The cross-language transferability of individual components, therefore, needs to be analyzed case by case in consideration of the typological distance between the two languages under acquisition.
Based on these theoretical foundations, the current thesis investigated cross-language transfer between Chinese and English, two typologically distant languages. Specifically, using the component approach, I examined cross-language transfer of two skills, i.e., phonological awareness and morphological awareness, to two literacy outcomes, i.e., word reading and vocabulary. I excluded orthographic processing, another important component skill in first language literacy development, from my investigation of cross-language transfer because orthographic processing is believed to be script-dependent (Abu-Rabia, 2001). This is particularly the case for two typologically different languages, such as Chinese and English, that share no orthographic or linguistic structures or print-to-sound mapping. Converging evidence has demonstrated that orthographic processing does not transfer between Chinese and English (Gottardo et al., 2001, 2001; McBride-Chang & Ho, 2005; M. Wang, Yang, & Cheng, 2009). On the other hand, phonological awareness and morphological awareness seem to be good candidates that may transfer cross-linguistically between Chinese and English. Below, I will discuss empirical evidence concerning cross-language transfer of phonological and morphological awareness.

Evidence of Phonological and Morphological Transfer

Cross-Language transfer of phonological awareness.

Phonological awareness, as reviewed in Chapter 2 of this thesis, is a strong predictor of reading development in both alphabetic languages like English (Adams, 1990; Bradley & Bryant, 1983; Bryant, MacLean, Bradley, & Crossland, 1990; Stanovich, 1986, 1992; Wagner & Torgesen, 1987) and nonalphabetic languages like Chinese (e.g., Ho & Bryant, 1997a; Hu & Catts, 1998; McBride-Chang & Ho, 2000; Siok & Fletcher, 2001). Consequently, phonological awareness is considered a universal factor that reading development is dependent on, across all
languages (Ziegler & Goswami, 2005), and hence the most important candidate for cross-linguistic transfer. Transfer of phonological awareness has attracted an enormous amount of attention in bilingual and biliteracy research (e.g., Cisero & Royer, 1995; Comeau et al., 1999; Durgunoğlu et al., 1993; Gottardo et al., 2001; Lafrance & Gottardo, 2005). By far, most studies on the issue were conducted among children who acquire two typologically similar languages, such as Spanish and English (e.g., Cisero & Royer, 1995; Durgunoğlu et al., 1993), or French and English (e.g., Comeau et al., 1999; Lafrance & Gottardo, 2005). Findings of these empirical studies have, in general, supported phonological transfer between two typologically similar languages in that phonological awareness in one language has been found to be not only a significant correlate with corresponding phonological abilities in the other language (e.g., Cisero & Royer, 1995; Comeau et al., 1999; Durgunoğlu et al., 1993), but also a unique predictor of reading abilities in that language (e.g., Comeau et al., 1999; Durgunoğlu et al., 1993; Lafrance & Gottardo, 2005).

Not until recently have efforts been made to empirically test transfer of phonological awareness between typologically distant languages (e.g, Hebrew and English, Wade-Woolley & Geva, 2000; Chinese and English, Gottardo et al., 2001; and Arabic and English, Saiegh-Haddad & Geva, 2008). In particular, learning of Chinese and English—likely the two most distant languages in the world—creates a most challenging situation for transfer to occur, and thus, has captivated fast growing research attention in recent times. Several studies explicitly tested cross-language effects of phonological awareness on literacy outcomes between Chinese and English, and the literacy outcomes in these studies are almost exclusively word-level reading abilities (Chow et al., 2005; Gottardo, Chiappe, Yan, Siegel, & Gu, 2006; Gottardo et al., 2001; M. Wang et al., 2005, 2009). Gottardo et al. (2001, 2006) tested cross-language effects of phonological
awareness on word-level reading among small samples of Cantonese-speaking English language learners (ELLs) from a wide age range (i.e., Grade 1 to Grade 8), and showed that Chinese rhyme detection was significantly correlated with English rhyme detection and phoneme deletion (Gottardo et al., 2001, 2006), and also uniquely predicted English real word and pseudoword reading after English phoneme deletion was controlled (Gottardo et al., 2001). Wang et al. (2005) found that, for Grade 2 and 3 Mandarin-speaking ELLs, Chinese onset matching skills were significantly correlated with English onset and rime matching skills, and that another measure of Chinese phonological awareness—tone awareness—uniquely predicted English pseudoword reading after controlling for English phoneme deletion. Wang et al. (2009) showed that Chinese onset and tone awareness uniquely predicted English real word reading, while only Chinese onset awareness predicted English pseudoword reading. Based on Cantonese-speaking Hong Kong second graders, Keung and Ho (2009) demonstrated that English rime detection uniquely predicted Chinese word reading when general abilities and within language phonological skills were controlled. In spite of using different phonological measures, these studies provided qualified evidence that phonological awareness does concurrently transfer between Chinese and English, two distant languages.

A couple of studies further tested longitudinal transfer of phonological awareness in bilingual and biliteracy development of Chinese and English (Chow et al., 2005; Pan, McBride-Chang, Shu, Zhang, & Li, 2011). Chow et al. (2005) investigated concurrent and longitudinal contributions of phonological processing, i.e., phonological awareness, rapid naming and verbal short-term memory, to word-level reading in Chinese and English among Hong Kong kindergarten children. They reported that only Chinese phonological awareness remained a significant predictor of English word reading, measured at Time 1 and 9 months later at Time 2,
after partialling out the influence of general abilities and other Time 1 Chinese measures. Pan et al. (2011) followed a group of 5-year-old kindergarten children in Beijing, and found these children’s syllable awareness at age 5 was predictive of English word reading at ages 8 and 10, when their initial variances in general abilities were removed. Both longitudinal studies (Chow et al., 2005; Pan et al., 2011) to some extent suggested that cross-language transfer of phonological awareness to word-level reading may remain over time, but neither of them had controlled phonological awareness in the target language. To confirm the longitudinal transfer of phonological awareness between Chinese and English, a more stringent test is required that includes this control.

These concurrent and longitudinal investigations have demonstrated, overall, the cross-language effects of phonological awareness between Chinese and English (Chow et al., 2005; Gottardo et al., 2001, 2006; M. Wang et al., 2005). However, the direction of phonological transfer to word-level reading is not yet clear: Is it from Chinese to English, English to Chinese, or bidirectional? Statistically, a transfer from Chinese to English is supported by a significant unique prediction from Chinese phonological awareness to English reading, whereas a transfer from English to Chinese requires significant predictions from English phonological awareness to Chinese reading. However, a very confusing picture has surfaced from the existing findings. Some studies only reported significant predictions from Chinese phonological awareness to English word reading, but not the other way around (e.g., Gottardo et al., 2001, 2006; M. Wang et al., 2005, 2009); some found predictions in both directions (Chow et al., 2005; Pan et al., 2011); yet one study (Gottardo et al., 2001), on the other hand, only revealed unique prediction from English phonological awareness to Chinese word reading, but not conversely. Some researchers once proposed that directions of transfer may be influenced by the proficiency level.
of the two languages under acquisition, in that transfer is more likely to happen from a more proficient language to a less proficient language (Deacon et al., 2007). This explanation, nevertheless, seems insufficient for the case of phonological transfer to word-level reading between Chinese and English. For example, Chinese-speaking ELLs tested in Gottardo et al. (2001, 2006) and Wang et al. (2005) were stronger in English, even though they were native speakers of Chinese. It seems the direction of transfer may interact with the linguistic context (in terms of what the society language is). As a case in point, the results based on Chinese-English bilingual children who used English as a societal language are different from Chinese children in Mainland China and Hong Kong where Chinese is the dominant language. Learning to read in the societal language is highly valued and systematically supported in schooling. Therefore, it is perhaps easier, or there are more opportunities, for bilingual children to incorporate phonological awareness acquired through learning an additional language into literacy development of the societal language.

As pointed out earlier, most studies reviewed here focus on cross-language effects of phonological awareness on word-level reading. It should be noted that phonological awareness may be related to vocabulary acquisition as explained in the lexical restructuring model (Metsala & Walley, 1998), and supported in several empirical studies (Avons et al., 1998; Bowey, 2001; Gathercole et al., 1999, 1992; Metsala, 1999). Presumably, such a relationship may extend cross-linguistically. That is to say, phonological awareness in one language may also significantly relate to vocabulary in the other. There are very few studies that provided some indication of cross-linguistic effects of phonological awareness on vocabulary involving Chinese –English bilingual children (Cheung et al., 2010). In fact, Cheung et al. (2010) included both word reading and vocabulary as the literacy outcomes in their investigation with a group of Hong Kong
children from kindergarten, Grade 2 and Grade 4. They reported that Chinese phonological awareness explained unique variance only in English word reading, but not in English vocabulary, after controlling for general abilities and other English measures. A limitation associated with this study is that the participants were from a wide age range (i.e., kindergarten to Grade 4). Developmental variation in their performance may have interfered with the test of transfer, and made the results hard to interpret. Therefore, more studies are needed for testing transfer of phonological awareness to vocabulary knowledge.

**Cross-Language transfer of morphological awareness.**

In comparison to transfer of phonological awareness, research on transfer of morphological awareness is scarce and only involves recent endeavours. Nevertheless, there is emerging evidence that morphological awareness is, besides phonological awareness, another component skill transferrable in biliteracy development (Deacon et al., 2007; Ramirez et al., 2010; Saiegh-Haddad & Geva, 2008; Schiff & Calif, 2007; M. Wang et al., 2006). The investigation of morphological transfer between two alphabetic languages has mostly focused on the derivational and inflectional aspects of morphological skills, and generally suggested that these skills may transfer both between two closely related languages, such as English and French (Deacon et al., 2007), and English and Spanish (Ramirez et al., 2010), and between two distant languages, such as Hebrew and English (Schiff & Calif, 2007). Specifically, derivational awareness has been found to transfer from L1 to L2 corresponding measures and word reading abilities for Hebrew-speaking Israeli children who learned English as a foreign language (Schiff & Calif, 2007), and for Spanish-speaking children who learned English as a second language in Canada (Ramirez et al., 2010). Transfer of inflectional awareness has been observed between English and French for French immersion children in Canada (Deacon et al., 2007).
In contrast, compound morphological awareness (hereafter compound awareness) seems more likely to transfer between Chinese and English (Wang et al., 2006; Zhang, in press). Wang et al. (2006) examined cross-language effects of both derivational awareness and compound awareness on word reading and reading comprehension for Chinese-speaking ELLs, but found that only compound awareness had cross-language effects on reading. Zhang (in press) directly compared the cross-language transferability of derivational and compound awareness between Chinese and English among children in China who learned English as a foreign language. His results demonstrated that the contribution of Chinese morphological awareness to English compound awareness was larger for compound words than for derived words. Stronger cross-language effects of compound morphology in Chinese-English biliteracy development is likely attributed to the typological distance between Chinese and English languages, in that compounding represents a productive morphological structure shared by both languages whereas derivation, a most common word formation in English, is rare in Chinese (Zhang, in press). Zhang et al. (2010) carried out an intervention study among fifth graders in China who learned English as a foreign language, to investigate whether training on compound awareness in one language would facilitate transfer to the corresponding awareness in the other. In the study, children were trained either on Chinese or English compound awareness, and their posttest performances were then compared to untaught control groups. The results showed that the Chinese intervention group outperformed the control groups on the English task, suggesting valid cross-linguistic effects of compound awareness from Chinese to English. Transfer from English to Chinese was also revealed, but only for those who had a high level of English proficiency.
Cross-language transfer of compound awareness between Chinese and English has also been examined in relation to several literacy outcomes, i.e., word-level reading, vocabulary knowledge, and reading comprehension (Pasquarella, Chen, Lam, Luo, & Ramirez, 2011; M. Wang et al., 2006, 2009). Wang et al. (2009) examined cross-language effects of compound awareness on word-level reading among Mandarin-speaking ELLs in Grade 1, and demonstrated that English compound awareness explained unique variance in Chinese character reading over and above Chinese compound awareness and several other related controls, suggesting children may apply their insights into structures of English compound words to the identification of Chinese characters. Wang et al. (2006) examined the cross-language effects of compound awareness on both word-level reading and reading comprehension with a group of Mandarin-speaking ELLs from a wide age range (i.e., Grade 1 to Grade 5). They found that English compound awareness uniquely predicted both Chinese character reading and reading comprehension. These findings suggest that advanced compound awareness may contribute to higher-level reading skill cross linguistically. Caution, however, needs to be exercised in interpreting these results, given that the study controlled neither compound awareness nor word reading of the target language in its statistical analysis.

Building on previous findings, Pasquarella et al. (2011) conducted a comprehensive test of cross-language effects of compound awareness among Mandarin-speaking ELLs in Grades 1 to 4. All three literacy outcomes (i.e., word-level reading, vocabulary and reading comprehension) were included in their structural equation models for the purpose of investigating to what extent compound awareness cross-linguistically contributes to different literacy outcomes between Chinese and English. The model revealed that the strongest cross-language effect of compound awareness was on vocabulary, rather than word reading or reading
comprehension. Specifically, English compound awareness uniquely contributed to Chinese vocabulary after other Chinese and English measures (in particular Chinese compound morphology and character reading) were also controlled. Their results raise an important question worth further investigation: do different component skills have differentiated cross-linguistic effects on different literacy outcomes? Specifically, is Chinese compound awareness more important for oral vocabulary than for word-level reading? Pasquarella et al.’s answer seems to be yes. Another study (Cheung et al., 2010) that also included multiple literacy outcomes in examination of cross-language relationship may, however, have a different answer. Cheung et al. (2010) measured both word reading and vocabulary in their investigation, involving Hong Kong kindergarten to Grade 4 children. They found that Chinese compound awareness explained unique variance in English word reading, but not in English vocabulary, after controlling for general abilities and other English measures including English morphological awareness. To solve the controversy, further investigation is needed with a more comprehensive analysis. This is one of the goals of the current study that I will elaborate later.

Similar to the transfer of phonological awareness to literacy, there has been no clear evidence in terms of the direction of cross-linguistic transfer for morphological awareness. Existing findings support either unidirectional transfer from English to Chinese (Pasquarella et al., 2011; M. Wang et al., 2006, 2009) or unidirectional transfer from Chinese to English (Cheung et al., 2010), or bidirectional transfer between Chinese and English (Zhang et al., 2010). The two-way transfer reported by Zhang et al. (2010) was based on a different methodology, and the study did not examine transfer in relation to literacy outcomes, so I will not compare it with the other findings in the following discussion. In the rest of the studies, the transference of compound awareness was bi-directional in accordance with the linguistic context. Specifically,
Chinese-speaking ELLs in North America who learn Chinese as a societal language tend to transfer compound awareness from English to Chinese (Pasquarella et al., 2011; M. Wang et al., 2006, 2009); whereas Hong Kong children who learn Chinese as a societal language tend to transfer compound awareness from Chinese to English (Cheung et al., 2010). Interestingly, these results were different from those of phonological awareness, even though two directions of transfer results were also identified. In that case, phonological transfer was from Chinese to English for Chinese-speaking ELLs in North America, and from English to Chinese (or bidirectionally) for children in a Chinese dominant environment. So far, it is not clear why this is the case. Nevertheless, it is clear that proficiency level (as proposed by Deacon et al., 2007) alone cannot explain transfer directions. Other factors such as linguistic context, oral proficiency level, reading level, and the types of component skills and literacy outcomes should also be considered. In the current study, I will compare the directions of phonological and morphological transfer to reading, to further understand the issue.

**Independent phonological and morphological transfer to word-level reading and oral vocabulary.**

To recapitulate, previous research has provided evidence for the transfer of phonological awareness and morphological awareness between Chinese and English, two sharply contrasted languages (e.g., Chow et al., 2005; Gottardo et al., 2001, 2006; M. Wang et al., 2005, 2006, 2009). However, the two component skills were often examined in separate studies or with separate statistical analyses. Since phonological and morphological skills have been conceptualized as interrelated component skills underlying literacy development (Plaut et al., 1996; Seidenberg & McClelland, 1989), it is important to ask whether each skill makes a cross-linguistic contribution to literacy development independent of the other. Previous studies have considered such
interrelations, but have only controlled relevant measures in the target language (i.e., when transfer is examined from Chinese to English, Chinese is regarded as the contributing language while English as the target language. In contrast, if transfer is from English to Chinese, English is the contributing language whereas Chinese is the target). For example, when examining transfer of Chinese morphological awareness to English word reading, previous studies only controlled for English phonological and/or morphological awareness (e.g., Cheung et al., 2010; Pasquarella et al., 2011; M. Wang et al., 2006, 2009). When investigating transfer of Chinese phonological awareness to English word reading, only English phonological and compound awareness and other related English measures were controlled (Cheung et al., 2010; M. Wang et al., 2009).

Understanding the independent cross-linguistic contributions of phonological awareness and morphological awareness, however, requires a more stringent test through a multivariate approach in which both component skills in the contributing language are included in one model for statistical testing. This stringent test also allows for a direct comparison of transferability of phonological and morphological awareness between Chinese and English. In the current research, I adopted this technique and explicitly tested independent cross-linguistic contributions of the two component skills.
CHAPTER 4. THE PRESENT STUDY

The current thesis investigated biliteracy development among young bilingual children in Canada who learn Chinese has a heritage language at home, while they are largely immersed in English as the societal language. For this group of children, existing research provides partial understanding of their literacy acquisition in two languages. On the one hand, research has focused on their acquisition of English literacy skills as demanded in school or in society; on the other hand, research on Chinese literacy development has been mostly conducted on children in a Chinese dominant language context, such as Mainland China, Hong Kong and Taiwan. What has been reviewed in Chapters 2 and 3 strongly suggests that biliteracy development is shaped by two fundamental influences: 1) cognitive and linguistic demands imposed in each of the two languages under acquisition; 2) interactions brought about by learning the two languages. Therefore, this thesis looked into the two influences among this group of Chinese-English bilingual children through two studies. Study 1 focused on the first influence through examining within-language relationships, whereas Study 2 focused on the second influence through investigating between-language interactions. It is important to note that literacy and biliteracy development is also influenced by social factors, which, however, are beyond the scope of the current thesis.

Study 1 compared the independent concurrent and longitudinal contributions of three component skills – phonological awareness, morphological awareness and orthographic processing – to concurrent and longitudinal early literacy outcomes in the form of word-level reading and vocabulary between Chinese and English. As indicated in the review, word-level reading and oral vocabulary are two fundamental early literacy skills for the further development
of reading comprehension abilities (Hoover & Gough, 1990). Nevertheless, the independent roles of phonological awareness, morphological awareness and orthographic processing in the two skills were not clear because previous studies have mostly focused on individual component skills and their relationships to literacy outcomes, rather than conceptualizing them as interrelated skills and examining them in one study. The objective of Study 1 was to capture the distinctive roles of these skills in word-level reading and oral vocabulary in Chinese and English separately. Through comparing the patterns between English and Chinese, Study 1 aimed to understand the similar or dissimilar cognitive and metalinguistic demands of acquiring word-level reading skills and vocabulary knowledge among young Chinese-English bilinguals living in an English dominant environment. Of particular interest in Study 1 were the following three research questions:

1. Among the three component skills (phonological awareness, morphological awareness and orthographic processing), which one(s) independently contribute to concurrent Chinese and English word-level reading and oral vocabulary knowledge when the other(s) are controlled?

2. Similarly, which one(s) of these skills longitudinally contribute to word-level reading and oral vocabulary measured one year later, after controlling for the auto-regressive effects of literacy skills at Time 1 in English and Chinese, respectively?

3. What are the similarities and differences in these predictive patterns between Chinese and English?
The objective of Study 2 was to examine the cross-linguistic effects of learning Chinese and English. In particular, I examined the independent cross-language effects of phonological and morphological awareness in one language to word reading and vocabulary in the other. In doing so, I aimed to achieve three general goals. The first was to compare the transferability of the two component skills across two distant languages within a single design. The second was to interpret their transferability in relation to specific literacy outcomes, so as to provide answers to questions like what skills cross-linguistically facilitate what aspect of literacy development. Another goal was to disentangle indirect and direct cross-language transfer of the component skills to reading. Indirect transfer is through the association between parallel skills in Chinese and English (e.g., the prediction of L1 phonological awareness to L2 reading is through the relationship between L1 and L2 phonological awareness); while direct transfer is beyond what has been accounted for by the indirect association (e.g., the unique prediction of L1 phonological awareness to L2 reading after the effect of L2 phonological awareness is partialled out). Five specific research questions were asked in Study 2:

1. Does phonological awareness cross-linguistically predict concurrent and subsequent word-level reading and/or oral vocabulary knowledge between Chinese and English after the influence of morphological awareness is removed? Are such cross-linguistic effects direct or mediated through the parallel phonological construct in the target language?

2. Similarly, does morphological awareness cross-linguistically predict concurrent and/or subsequent word-reading and/or oral vocabulary between Chinese and English, after the influence of phonological awareness is taken into consideration? Does morphological awareness contribute cross-linguistically to literacy
outcomes directly or indirectly through the parallel constructs in the target language?

3. With regard to the direction of transfer, are cross-linguistic effects investigated in 1) and 2) from Chinese to English, English to Chinese, or in both directions?

4. Do the two metalinguistic skills (i.e., phonological and morphological awareness) cross-linguistically affect the two literacy skills (i.e., word-level reading and oral vocabulary) differently?
CHAPTER 5. METHOD

Participants

Participants were 91 typically developing Chinese-English bilingual children, recruited from entry-level Chinese heritage language classes across the Greater Toronto Area in Canada. Many of these heritage language classes are composed of children from multiple age groups. Among the 91 participants in our sample, 56 were in kindergarten ($M_{age} = 5.23$ years, $SD = 0.53$ years; 25 girls) and the other 35 were in Grade 1 ($M_{age} = 6.58$ years, $SD = 0.33$ years; 12 girls) at the initial testing of this study (Time 1). Then, these children were tested again approximately one year later (Time 2). At Time 2, these kindergarten and Grade 1 children had moved up to Grades 1 and 2, respectively, and 42 Grade 1 and 24 Grade 2 children remained in the study while the rest of the participants left the study because they moved out of the area with their families. Statistical comparison was conducted between children who remained and those who left on their performance at Time 1, and yielded no difference between the two groups ($ps > .98$).

These bilingual children were of Chinese descent, with both parents being first-generation immigrants from a Chinese-speaking country or region, e.g., the Mainland of the People’s Republic of China (PRC) or Taiwan. Sixty-two percent of our participants were born in

1 Our participants were children of Chinese immigrants who are relatively new in Canada. For this population, relocation is quite common for a variety of reasons, such as changing jobs, buying a house, and even immigration backflow. I managed to contact and test the participants who had moved out of their former school yet still stayed in the same school board. However, those who were lost to the study had completely left the school boards for which the ethics approval had been obtained.
Canada, and the other 38% were born in the PRC, Taiwan, or Singapore and immigrated to Canada with their parents at an average age of 3 years and 5 months. On average, their parents had completed a university education and worked in all walks of life.

All of the participants attended regular English public schools, where English was their language of schooling and the primary communication tool with classmates and friends outside of class. However, they still had plenty of opportunities to be exposed to Mandarin Chinese within their households. According to the parents’ responses to our family questionnaire, Mandarin Chinese was the primary means of communication between children and parents. Over 80% of the children and 85% of the parents were reported as using Mandarin at home most of the time in their daily conversations. In addition, these children also attended 2.5 hours of heritage language classes on weekends or after school every week, where they learned Chinese through both informal literacy activities and formal literacy instruction. The informal activities included popular Chinese rhythms and songs and culturally-enriched stories, and the formal instruction included shared reading of short stories, and reading and writing of simplified Chinese characters\(^2\) guided through leveled Chinese textbooks specially designed for learning Chinese as a heritage language. Since these children came from different English public schools, and the English instruction they had received might be varied. But based on Ontario literacy curriculum guideline (Ontario Ministry of Education, 2003), shared reading, guided reading, and reading aloud and independent reading were common literacy practice in classrooms.

\(^2\) Simplified Chinese characters are standard Chinese characters used in Mainland China of the People’s Republic of China and Singapore. They were derived from traditional Chinese characters by decreasing the number of strokes and simplifying the forms of a sizable proportion of traditional characters. Traditional Chinese characters are still an official writing system used in Taiwan, Hong Kong and Macau.
Measures

We assessed the participants’ cognitive, metalinguistic, linguistic and literacy skills twice, approximately one year apart. A battery of standardized and non-standardized measures was administered at Time 1 to evaluate children’s nonverbal reasoning, phonological awareness, morphological awareness, orthographic processing, oral vocabulary and word-level reading in both Chinese and English. At Time 1, the parents were also asked to fill out a family questionnaire regarding family background, home literacy activities, and children’s language use at home. Below are the detailed descriptions of all the measures. Children were tested again at Time 2 on outcome measures of word-level reading and oral vocabulary in the two languages.

Background and cognitive measures.

Family questionnaire.

Parents were asked to complete a questionnaire about their child’s social, economic, immigration, and linguistic background at the beginning of the study at Time 1. For example, parents were asked to report their country of origin, how long their family had been living in Canada, and what languages they used at home, as well as the contexts and frequency in which the languages were used and read. Data collected with the family questionnaire was used for descriptive information of our sample’s background, which has been summarized and reported in the earlier section, Participants. We used mother’s education in the data analyses as a proxy for socio-economic status. This was on a scale of 1 to 6, where 1 = primary school, 2 = junior high school, 3 = high school, 4 = college, 5 = university degree, and 6 = graduate degree. For the questions asked in the family questionnaire, please see Appendix A.
Nonverbal reasoning.

Nonverbal reasoning was measured at Time 1 with the Raven Standard Progressive Matrices (SPM; Raven, 1958) because the task administration and completion involves minimal language. The SPM comprises 5 sets (A to E) of 12 items each, with items within a set in order of increasing difficulty. However, provided that our participants were still at the lowest age range for which the test was intended, only the first three sets (A, B, and C) were used in the present study to control testing time. Each item showed a picture with a missing section, and the child was asked to analyze and choose one out of the six patterns listed below the picture that best matched the missing section. All pictures and patterns were presented in black against a white background. This task was only administered at Time 1, and the Cronbach’s α sample reliability coefficient was .83.

English Measures.

English word reading.

English word reading skills were assessed at both times with the Letter-Word Identification Subtest from the Woodcock-Johnson III Tests of Achievement (Woodcock, McGrew, & Mather, 2001). The task was administered based on the standardized procedure. Children were asked to identify 14 letters and to read 62 words of increasing difficulty in the task. The test was discontinued if the child made six consecutive errors. The Cronbach’s α sample reliability coefficients for this task were .97 at Time 1 and .96 at Time 2.

English oral vocabulary.

A shortened version of the Peabody Picture Vocabulary Test-III A (PPVT-III A; Dunn & Dunn, 1997) was used to assess children’s oral receptive vocabulary in English at both times. Every third item of the original PPVT-III was administered to reduce testing time within this
large test battery (e.g., 1st, 4th, 7th...item; a total of 60 items; similar to Wang et al., 2006). In each item, the experimenter presented four pictures to the child, and then stated a word orally twice. The child heard the word, and chose one out of the four pictures that best described the word. Three practice items were given before the 60 testing items were administered to ensure that the child understood the procedure of the task. The Cronbach’s α sample reliability coefficients for this task were .54 at Time 1 and .64 at Time 2.

*English phonological awareness.*

Phonological awareness in English was assessed at Time 1 using the Elision subtest of the Comprehensive Test of Phonological Processing (CTOPP; Wagner, Torgesen, & Rashotte, 1999). This test contained 6 practice and 20 test items. In each item, the child first heard a word, and was then asked to repeat the word and say the word without saying one part of it. A deleted part could be either a syllable at the initial or final position of a word, or a phoneme at the initial, middle or final position of a syllable (e.g., “Say doughnut; now say doughnut without saying dough.” Or “say cat; now say cat without the /k/.”). Following the standardized procedure, testing was terminated when the child made three consecutive errors. This task contained 24 test items at Time 1 and 27 items at Time 2. The Cronbach’s α sample reliability coefficient for this task was .93.

*English derivational morphologic awareness.*

Children’s awareness of derived and inflected words was examined at Time 1 with a task adapted from Carlisle (2000). The original task was created for Grade 5 children, and assessed children’s awareness of the relations of base and derived/inflected forms with two types of items. One type required the decomposition of a derived/inflected word to finish a sentence. For example, the child needs to decompose a target word, e.g., *popularity*, to a proper form, e.g.,
popular, in completing a sentence: The girl wants to be_____. The other required the production of a derived/inflected word to finish a sentence. For example, the child needs to use the target word, e.g., adventure, to produce a derived word, e.g., adventurous, in completing a sentence: The girl wants to be_____. Given that the participants of this study were much younger, only the second type was used so as to reduce the task difficulty to a proper level. The task was administered orally with no reading involved. The child heard a target word, e.g., magic, followed by an incomplete sentence, e.g., The performer was a good_____. The child was then asked to complete the sentence by saying the proper derived form of the target word, e.g., magician. The target words required manipulation of either nominal, adjectival, adverbial, or verbal morphemes. This task contained 20 test items at Time 1 and 28 items at Time 2 (see Appendix B). The Cronbach’s α sample reliability coefficient was .88.

**English compound morphological awareness.**

This test was adapted from McBride-Chang et al. (2005) to evaluate children’s ability to form new words using the rule of compounding at Time 1. It included 2 practice items and 15 test items. In each item, children were presented with the definition of a compound word, and were then asked to make an analogy to create a compound of a similar structure using newly presented concepts. This task was also administered orally. For example, the child heard the question, “Early in the morning, we can see the sun rising. This is called a sunrise. At night, we might also see the moon rising. What could we call this? (moonrise)”, and then presented their answer orally. The compound words used as definitions were all real, while the compound words expected as answers were all pseudo, just to avoid any effect of familiarity. The Cronbach’s α sample reliability coefficient was .90. See Appendix C for the items included in the task.
**English orthographic processing.**

Children’s sensitivity to legitimate spelling patterns was assessed at Time 1 by a published judgment task (Conrad & McNutt, 2008; Deacon, Chen, Luo, & Ramirez, 2011) (see Appendix D). The task consisted of 20 pairs of nonwords. In each pair, the two nonwords had the same pronunciation. However, one contained a letter combination that occurred frequently in English, while the other did not (e.g., *vake-vayk*, respectively). The child was asked to decide which of two visually presented letter-strings looked more like a real word in English. The rarity or non-existence of a letter combination in English was confirmed using the MRC Psycholinguistic Database (Wilson, 1988). Participants were given feedback on three practice items. The Cronbach’s α sample reliability for this task was .61.

**Chinese Measures.**

**Chinese character reading.**

This task was administered at both times, and consisted of 125 unrelated characters selected from the 12 volumes of the Elementary School Textbooks (Elementary Education Teaching and Research Center, Beijing Education and Science Institute, 1996) employed in the Chinese language curricula from Grade 1 to Grade 6 in the Mainland of the PRC. It started with highly frequent characters (e.g. 人 ‘person’, 小 ‘small’) and moved to less frequent ones (e.g. 蹦 ‘slink’, 黝 ‘swarthy’). The test was discontinued when the child misread 10 characters consecutively. The total number of correctly read characters was recorded as the character reading score. The Cronbach’s α sample reliability for this task was .97.

**Chinese oral vocabulary.**

Children’s oral vocabulary was measured with a receptive task at Time 1 and an expressive task at Time 2. At Time 1, Chinese oral receptive vocabulary was translated from the
shortened version of the PPVT-III A (Dunn & Dunn, 1997). The selection of the items for the shortened task followed a similar procedure as specified in the English test of oral vocabulary. However, to avoid overlapping items for the Chinese and English tasks, we chose a different set of items (e.g., the 2nd, 5th, 8th … item, instead of the 1st, 4th, 7th … item used for the English measure; a total of 60 items). The experimenter orally presented each item twice and the child selected the picture out of four options that best described the word heard. Children were given three practice items. The Cronbach’s α sample reliability of this Time 1 oral vocabulary measure was .82.

At Time 2, Chinese oral vocabulary was assessed with a picture naming task adapted from Snodgrass and Vanderwart (1980). The task included a total of 120 pictures presented one after another by the experimenter; the child was asked to name each of them. The original picture naming task (Snodgrass & Vanderwart, 1980) consists of 260 items. The 120 items included in the current task were selected based on Liu’s (2006) investigation among Chinese children on their age of acquisition of the words used in the original test. For the selected items, the mean age of acquisition was 6.5 years and the range of acquisition was from 2.5 to 12 years. On each item the child could receive a maximum of 3 points. To obtain a full score (i.e., 3 points) on an item, the child’s response to the picture had to be the targeted response or another response that was semantically synonymous. A 2-point response was one that was the categorical term of the targeted response. For example, the response 球 (ball) for the targeted response 篮球 (basketball) would merit 2 points. In the case where the child’s response belonged to the same category as the targeted response (e.g., responding 排球 (volleyball) for the targeted response 篮球 (basketball)), the child would be given 1 point. The Cronbach’s α sample reliability of this Time 2 oral vocabulary measure was .96.
**Chinese phonological awareness.**

Chinese phonological awareness was assessed at Time 1 with an onset and syllable deletion task (see Appendix E). The child was asked to delete either a syllable from an initial, middle, or end position from a multiple-syllable word, or the onset from a syllable. Both real and pseudo items were used to control for familiarity. For example, children were asked to delete /dao1/ from /tu3dao1mei3/, and to delete /s/ from /se4/. The task contained 4 practice items and 24 test items, with half being syllable deletion and the other half being onset deletion. The Cronbach’s α sample reliability of this task was .95.

**Chinese compound morphological awareness.**

Adapted from McBride-Chang et al. (McBride-Chang, Cho, et al., 2005), this task parallels the English test of compound morphological awareness (see Appendix F). The experimenter provided the definition of an animal or an object that was already familiar to the child, and then asked the child to create a name for an imaginary animal or object that bore some resemblance to it. This was used to evaluate the child’s ability to extract morphemes from the name of the given animal or object, and to combine them with other morphemes to create novel compounds. For example, “斑马是身上有斑纹的一种马, 那么身上有斑纹的牛我们叫什么? [Striped horse (Zebra) is a kind of horse with stripes on the body. What should we call a cow with stripes on the body?] (斑牛 striped cow).” The compound words used as definitions are all real, while the compound words expected as answers were all pseudo, just to avoid any effect of familiarity. This test included 15 items. Two practice items were administered prior to the test items with feedback to ensure children’s comprehension of the task requirements. The Cronbach’s α sample reliability of this task was .86.
Chinese orthographic processing.

This task assessed awareness of legal positions and formation of Chinese radicals (see Appendix G). The task contained 4 practice and 24 experimental items. Half of the items included a pair of pseudo-characters, contrasting one with its components in legal positions (e.g. 坑) and the other with its components in illegal positions (e.g. 坑, when the radical 氵 can only appear on the left side of a character). The other half of the items included a pair of pseudo-characters, contrasting one with two correctly formed radicals and the other with a correctly formed radical and an ill-formed radical (e.g., 現 and 览; the correct answer was 觠). The child was asked to indicate which of the two pseudocharacters looked more like a real Chinese character. The Cronbach’s α sample reliability of this task was .32. The surprisingly low reliability at Time 1 can most likely be attributed to the very limited print exposure that the children had then.

Procedure

Testing occurred in a quiet location in the participant’s school or heritage language class. At both Time 1 and Time 2, all measures were administered individually to each child. The testing was completed within two sessions on separate days. All English measures were given in one session, while the Chinese measures were given in the other. Each session lasted approximately 45 minutes and testing was counterbalanced within each session. Testing for each child at Time 1 and Time 2 was completed within a period of two to three weeks from November 2006 to March 2007, and from November 2007 to March 2008, respectively. To maintain the same time length between Times 1 and 2 for each child, we recorded the dates of testing at Time 1 for each child and ensured they were tested again around the same time at Time 2.
The experimenters were native speakers of English or Mandarin who only administered the tasks in their native language. They were graduate and undergraduate students in psychology and had received extensive training (about two months) on the administration of our testing battery and the ethics of working with children. To reduce tester effect, all experimenters were required to strictly follow the testing protocol and instruction scripts provided for each task. Task instructions were generally given in Chinese or English, depending on the task under investigation. In some cases, the experimenter was allowed to switch to the child’s dominant language when explaining the task to ensure a complete understanding of the requirements from the child, yet the testing items had to be given in the targeted language.

**Handling Missing Values**

The original dataset contained missing values due to absence at each testing session or participant attrition from Time 1 to Time 2 as a result of relocation. Approximately 15% of the variables, 44% of cases and 15% of the values were missing. Missing values became a pressing issue of the current study. The existing literature basically suggested three standard statistical methods to handle multivariate data with missing values: (a) listwise deletion, or complete case analysis, (b) pairwise deletion, or available case methods, and (c) imputation, or filling in the missing value with estimated scores (Little & Rubin, 1987, 1989). The first two approaches are default procedures of many statistical packages and have been the dominant procedures in treating missingness in educational research (Peugh & Enders, 2004); nevertheless, they are associated with obvious disadvantages. For example, the listwise deletion approach may lead to potential, in my case dramatic, loss of information in discarded incomplete cases. The pairwise deletion leads to the change of sample bases from analysis to analysis according to the pattern of missing data, and hence, biases the comparison of results across analyses. In the current research,
cross-language patterns were evaluated based on such comparisons; therefore, pairwise deletion
was not a suitable solution, either.

With regard to imputation, there are two general categories, single and multiple
imputation (MI). Single imputation often involves simple substitution of missing values, such as
mean substitution, or regression substitution. The former imputes missing data using group
averages, which on the one hand preserves observed samples means, but on the other hand,
distorts the covariance structure and reduces variance and covariance. The latter technique
imputes missing values from regression models, a procedure that can easily inflate observed
correlations (Schafer, 1997). The biggest limitation of single imputation lies in the probability of
underestimating the variance of estimates (Little & Rubin, 1987). Multiple imputation, in
contrast, has been argued to be superior to many aforementioned simple approaches in terms of
handling missingness (Enders, 2001). It involves a procedure of replacing missing values by \( m > 1 \)
plausible estimates from their predictive distribution, and thereafter to generate \( m \) complete
datasets (Rubin, 1987). Then, statistics of interest need to be calculated based on each of the \( m \)
datasets, and then integrated based on the procedure recommended by Rubin (1987) and Schafer
(1997) to produce overall estimates and standard errors to reflect missing value uncertainty.

To avoid missing bias and increase statistical power, the current research adopted the
multiple imputation approach to estimate missing values. Before imputation, I first conducted the
missing value analysis using SPSS to examine the missing patterns. Two sets of results available
in this analysis were of particular interest. One was the separate variance \( t \) tests, which recoded
each variable into one with two dichotomized values, present vs. missing, based on status of
missingness, and examined the effect of the missingness of this variable on all other variables.
The results suggested that none of the \( t \) tests were significant, \( ts \leq 2.20, ps \geq .062 \). Even though
several statistics were approaching significance, the overall non-significant findings tentatively demonstrated missingness was random in the data. Most importantly, the results of the Little’s MCAR test, a stringent test of the missing-completely-at-random assumption, was found to be nonsignificant, $\chi^2(283) = 303.92, p = .118$, further confirming that the missing patterns were indeed random.

Because missing-at-random is assumed in the data, I then imputed missing values using a multiple imputation procedure available in SPSS. Rubin (1987) suggested that 3-5 imputations (i.e., $m = 3$ to 5) are sufficient to produce excellent results. Statistically, the efficiency of an estimate based on $m$ imputations can be calculated based on the following formula (Rubin, 1987):

$$
\left(1 + \frac{\gamma}{m}\right)^{-1},
$$

Where $\gamma$ is the fraction of missing information for the quantity being estimated. The fraction $\gamma$ quantifies how much more precise the estimate might have been if no data had been missing. The current dataset has 15% missing information ($\gamma = .15$). Therefore, with $m = 2$, I would have achieved 57% efficiency; with $m = 3$, efficiency increases to 95%; with $m = 5$, efficiency rises to 97%. Since 5 imputations have provided a very high proficiency, when the number increases to $m = 10$, efficiency would be not much higher, 98%. Therefore, I chose 5 imputations for the study.

Then I conducted identical analyses of interest on the 5 datasets separately, using regular statistic packages, SPSS and AMOS, needed for this study. The 5 sets of results were then combined manually using simple rules provided by Rubin (1987) or automatically using general purpose multiple imputation software, NORM (Schafer, 1997). To ensure that no statistical bias was introduced during the MI procedure, I compared the synthesized results and the results of the
original dataset with missing values, and found the results were basically the same. In the results sections of the two studies, I only report the pooled results based on imputed datasets.
CHAPTER 6. STUDY ONE

Participants

Data for this study was collected from the group of 91 Chinese-English speaking bilinguals whose composition and characteristics are described in the Method chapter. There were 56 kindergarten children and 35 Grade 1 children at Time 1. At Time 2, 42 kindergarten and 24 grade children remained in our sample. To maintain a large enough sample size for valid statistical analysis, I conducted missing data analysis and multiple imputations. Please refer to the previous chapter for the complete procedure for handling missing values.

Measures

All of the measures listed in the Method chapter were included in this study except for the English test of compound morphological awareness. For the purpose of investigating within-language relationship, the Times 1 and 2 derivational morphological awareness measure was used for English, given that the majority of English words are formed through derivation (Nagy & Anderson, 1984); whereas for Chinese, the Times 1 and 2 compound morphological awareness measure was used as Chinese words are primarily formed by compounding (Packard, 2000). The measures also included maternal education and nonverbal reasoning, as well as Times 1 and 2 phonological awareness, orthographic processing, oral vocabulary, and reading in Chinese and English. Detailed descriptions of these measures were provided in the previous chapter.
Results

Descriptive statistics.

Means and standard derivations of maternal education and nonverbal reasoning, and Time 1 and Time 2 word/character reading, oral vocabulary, phonological awareness, morphological awareness and orthographic processing in English and Chinese are reported in Table 2. The standard scores of the English word reading task are also reported, and show that these Chinese-English bilingual children’s English word reading ability was above the norms established for the monolingual English-speaking population. Raw scores are presented for all of the variables. When nonverbal abilities were controlled, Grade 1 children performed similarly to kindergarten children on all Chinese measures ($ps \geq .10, \eta^2 \leq .04$) excepted for Chinese phonological awareness ($p = .040, \eta^2 \leq .054$). Similar performance was found between the two cohorts on most English measures ($ps \geq .08, \eta^2 \leq .06$), except for English phonological awareness ($p < .001, \eta^2 = .14$) and Time 1 English word reading ($p = .010, \eta^2 = .13$). Children in both cohorts improved from Time 1 to Time 2 on word-level reading and oral vocabulary in Chinese and English ($ps \leq .004, \eta^2 \geq .11$), except for English oral vocabulary ($p = .696$). Further examination of the skewness and kurtosis of the raw scores also suggested that all variables were normally distributed, an important assumption satisfied for further analyses.
Table 2
Means and Standard Derivations of the Measures by Grade.

<table>
<thead>
<tr>
<th>Measures</th>
<th>Min-Max</th>
<th>Sample Specific Reliability</th>
<th>Kindergarten cohort (n=56)</th>
<th>Grade 1 cohort (n=35)</th>
<th>ANCOVA(^a) (Kindergarten vs. Grade 1)</th>
<th>Combined ((N=91))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Cronbach’s (\alpha)</td>
<td>(M) (SD)</td>
<td>(M) (SD)</td>
<td>(F)</td>
<td>(M) (SD)</td>
</tr>
<tr>
<td>Maternal Education</td>
<td>1-6</td>
<td>N/A</td>
<td>4.89 (0.97)</td>
<td>4.89 (0.87)</td>
<td>N/A</td>
<td>4.89 (0.92)</td>
</tr>
<tr>
<td>Nonverbal Reasoning</td>
<td>0-36</td>
<td>(0.83)</td>
<td>14.84 (3.74)</td>
<td>21.83 (6.10)</td>
<td>N/A</td>
<td>17.53 (5.86)</td>
</tr>
<tr>
<td>T1 Chinese Phonological Awareness</td>
<td>0-24</td>
<td>(0.95)</td>
<td>10.11 (7.53)</td>
<td>17.89 (5.79)</td>
<td>5.02*</td>
<td>13.10 (7.86)</td>
</tr>
<tr>
<td>T1 Chinese Compound Awareness</td>
<td>0-15</td>
<td>(0.86)</td>
<td>4.43 (3.67)</td>
<td>7.87 (3.40)</td>
<td>2.87</td>
<td>5.76 (3.92)</td>
</tr>
<tr>
<td>T1 Chinese Orthographic Processing</td>
<td>0-24</td>
<td>(0.32)</td>
<td>12.27 (2.48)</td>
<td>14.97 (2.77)</td>
<td>2.63</td>
<td>13.31 (2.90)</td>
</tr>
<tr>
<td>T1 Character Reading</td>
<td>0-125</td>
<td>(0.97)</td>
<td>16.70 (17.06)</td>
<td>29.50 (19.62)</td>
<td>3.12</td>
<td>21.62 (19.04)</td>
</tr>
<tr>
<td>T1 Chinese Oral Receptive Vocabulary</td>
<td>0-60</td>
<td>(0.82)</td>
<td>27.73 (7.50)</td>
<td>33.95 (6.95)</td>
<td>1.85</td>
<td>30.12 (7.87)</td>
</tr>
<tr>
<td>T2 Character Reading</td>
<td>0-125</td>
<td>(0.97)</td>
<td>25.76 (21.17)</td>
<td>31.95 (29.07)</td>
<td>0.15</td>
<td>28.14 (21.61)</td>
</tr>
<tr>
<td>T2 Chinese Oral Expressive Vocabulary</td>
<td>0-360</td>
<td>(0.96)</td>
<td>136.20 (83.58)</td>
<td>162.79 (109.75)</td>
<td>0.59</td>
<td>146.43 (83.40)</td>
</tr>
<tr>
<td>T1 English Phonological Awareness</td>
<td>0-20</td>
<td>(0.93)</td>
<td>4.09 (3.78)</td>
<td>9.63 (5.55)</td>
<td>13.56***</td>
<td>6.22 (5.31)</td>
</tr>
<tr>
<td>T1 English Derivational Awareness</td>
<td>0-20</td>
<td>(0.88)</td>
<td>4.91 (3.54)</td>
<td>9.23 (5.12)</td>
<td>8.23**</td>
<td>6.57 (4.68)</td>
</tr>
<tr>
<td>T1 English Orthographic Processing</td>
<td>0-20</td>
<td>(0.61)</td>
<td>10.72 (3.18)</td>
<td>14.11 (3.09)</td>
<td>0.78</td>
<td>12.02 (3.57)</td>
</tr>
<tr>
<td>T1 English Word Reading</td>
<td>0-76</td>
<td>(0.97)</td>
<td>22.31 (10.24)</td>
<td>36.78 (11.91)</td>
<td>11.09**</td>
<td>27.87 (12.95)</td>
</tr>
<tr>
<td>T1 English Word Reading (Std Scores)</td>
<td></td>
<td></td>
<td>119.02 (23.22)</td>
<td>113.03 (32.46)</td>
<td></td>
<td>116.71 (27.13)</td>
</tr>
<tr>
<td>T1 English Oral Receptive Vocabulary</td>
<td>0-60</td>
<td>(0.54)</td>
<td>32.46 (4.49)</td>
<td>33.83 (5.20)</td>
<td>.31</td>
<td>32.99 (4.77)</td>
</tr>
<tr>
<td>T2 English Word Reading</td>
<td>0-76</td>
<td>(0.96)</td>
<td>34.93 (12.46)</td>
<td>43.53 (14.72)</td>
<td>3.60</td>
<td>38.24 (13.32)</td>
</tr>
<tr>
<td>T2 English Word Reading (Std Scores)</td>
<td></td>
<td></td>
<td>124.78 (17.32)</td>
<td>109.80 (27.79)</td>
<td></td>
<td>119.11 (22.88)</td>
</tr>
<tr>
<td>T2 English Oral Receptive Vocabulary</td>
<td>0-60</td>
<td>(0.64)</td>
<td>31.01 (6.15)</td>
<td>33.89 (8.61)</td>
<td>2.84</td>
<td>32.12 (6.62)</td>
</tr>
</tbody>
</table>

Note. T=Time. *** \(p < .001\); ** \(p < .01\); * \(p < .05\). a. ANCOVA controlled for nonverbal reasoning.
Zero order correlation matrices among the English measures are reported separately for kindergarten and Grade 1 children in Table 3. The two age groups revealed rather similar patterns of relationships. Autoregressive relationships for word reading and vocabulary were correlated in a small to moderate magnitude, $0.28 \leq r \leq 0.67$, $ps < 0.05$. Phonological awareness, morphological awareness, and orthographic processing were moderately correlated with word reading concurrently, $0.53 \leq rs \leq 0.73$, $ps < 0.001$, but related to subsequent word reading in a smaller magnitude, $0.26 \leq rs \leq 0.49$, $ps < 0.05$. Morphological awareness was, however, the primary correlate of concurrent and subsequent oral vocabulary, $0.30 \leq rs \leq 0.54$, $ps < 0.05$.

Similar correlation analyses were performed on Chinese measures for kindergarten and Grade 1 (see Table 4). The correlational patterns were also similar across the two groups. Autoregressive correlations for character reading and oral vocabulary were moderate, $0.49 \leq rs \leq 0.60$, $ps < 0.001$. Morphological awareness seemed to be the strong correlate of concurrent and subsequent character reading, $0.38 \leq rs \leq 0.41$, $ps < 0.05$, and oral vocabulary, $0.49 \leq rs \leq 0.62$, $ps < 0.05$. Interestingly, Chinese reading and oral vocabulary were moderately correlated with each other at Time 1 and Time 2 for both grades $0.41 \leq rs \leq 0.63$, $ps < 0.01$. 
Table 3

Zero Order Correlation Matrices among the English Measures Summarized Separately for Kindergarten (Left of the Diagonal; n=56) and Grade 1 (Right of the Diagonal; n=35).

<table>
<thead>
<tr>
<th>Measures</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGE</td>
<td>–</td>
<td>-.05</td>
<td>.21</td>
<td>.21</td>
<td>.19</td>
<td>.08</td>
<td>.31*</td>
<td>.04</td>
<td>-.01</td>
<td>.25</td>
</tr>
<tr>
<td>ME</td>
<td>-.14</td>
<td>–</td>
<td>.31*</td>
<td>.43*</td>
<td>.11</td>
<td>.42**</td>
<td>.29*</td>
<td>.20</td>
<td>.43**</td>
<td>.15</td>
</tr>
<tr>
<td>NR</td>
<td>.46**</td>
<td>.04</td>
<td>–</td>
<td>.24</td>
<td>.02</td>
<td>.18</td>
<td>.22</td>
<td>.03</td>
<td>.23</td>
<td>.06</td>
</tr>
<tr>
<td>T1 EWR</td>
<td>.29*</td>
<td>.22</td>
<td>.15</td>
<td>–</td>
<td>.42*</td>
<td>.73***</td>
<td>.63***</td>
<td>.61***</td>
<td>.61***</td>
<td>.36*</td>
</tr>
<tr>
<td>T1 EOV</td>
<td>.12</td>
<td>.27*</td>
<td>.14</td>
<td>.14</td>
<td>–</td>
<td>.37*</td>
<td>.54***</td>
<td>.18</td>
<td>.36*</td>
<td>.29*</td>
</tr>
<tr>
<td>T1 EPA</td>
<td>.34*</td>
<td>.19</td>
<td>.21</td>
<td>.53***</td>
<td>.14</td>
<td>–</td>
<td>.58***</td>
<td>.38*</td>
<td>.46**</td>
<td>.23</td>
</tr>
<tr>
<td>T1 EDA</td>
<td>.37*</td>
<td>.09</td>
<td>.11</td>
<td>.56***</td>
<td>.37**</td>
<td>.61***</td>
<td>–</td>
<td>.55***</td>
<td>.59***</td>
<td>.48**</td>
</tr>
<tr>
<td>T1 EOP</td>
<td>.17</td>
<td>.11</td>
<td>.09</td>
<td>.61***</td>
<td>-.01</td>
<td>.18</td>
<td>.29*</td>
<td>–</td>
<td>.45**</td>
<td>.21</td>
</tr>
<tr>
<td>T2 EWR</td>
<td>.16</td>
<td>.19</td>
<td>.03</td>
<td>.67***</td>
<td>.20</td>
<td>.26*</td>
<td>.27*</td>
<td>.45***</td>
<td>–</td>
<td>.38*</td>
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<tr>
<td>T2 EOV</td>
<td>.02</td>
<td>.21</td>
<td>-.02</td>
<td>.25*</td>
<td>.28*</td>
<td>.19</td>
<td>.30*</td>
<td>.18</td>
<td>.35*</td>
<td>–</td>
</tr>
</tbody>
</table>

Note. *** p < .001; ** p < .01; * p < .05. T1 = Time 1; T2 = Time 2. ME = Maternal Education; NR = Nonverbal Reasoning; EWR = English Word Reading; EOV = English Oral Vocabulary; EPA = English Phonological Awareness; EDM = English Derivational Awareness; EOP = English Orthographic Processing.
Table 4

**Zero Order Correlation Matrices among the Chinese Measures Summarized Separately for Kindergarten (Left of the Diagonal; n=56) and Grade 1 (Right of the Diagonal; n=35)**

<table>
<thead>
<tr>
<th>Measures</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGE</td>
<td></td>
<td>.21</td>
<td>-.18</td>
<td>.01</td>
<td>-.17</td>
<td>.06</td>
<td>.10</td>
<td>-.21</td>
<td>-.05</td>
<td></td>
</tr>
<tr>
<td>ME</td>
<td>-.14</td>
<td></td>
<td>.31*</td>
<td>.19</td>
<td>.40*</td>
<td>.38*</td>
<td>.45*</td>
<td>.12</td>
<td>.16</td>
<td>.07</td>
</tr>
<tr>
<td>NR</td>
<td>.46**</td>
<td>.04</td>
<td></td>
<td>.06</td>
<td>.42**</td>
<td>.42**</td>
<td>.45**</td>
<td>.49***</td>
<td>.12</td>
<td>-.01</td>
</tr>
<tr>
<td>T1 CCR</td>
<td>.33*</td>
<td>-.01</td>
<td>.23</td>
<td></td>
<td>.50**</td>
<td>.32*</td>
<td>.38*</td>
<td>.09</td>
<td>.51***</td>
<td>-.16</td>
</tr>
<tr>
<td>T1 COV</td>
<td>.14</td>
<td>.20</td>
<td>.26*</td>
<td>.41**</td>
<td></td>
<td>.27*</td>
<td>.62***</td>
<td>.20</td>
<td>.25*</td>
<td>.49**</td>
</tr>
<tr>
<td>T1 CPA</td>
<td>.341</td>
<td>.12</td>
<td>.38**</td>
<td>.25*</td>
<td>.30*</td>
<td></td>
<td>.39*</td>
<td>.29</td>
<td>.20</td>
<td>.06</td>
</tr>
<tr>
<td>T1 CCA</td>
<td>.37*</td>
<td>.11</td>
<td>.34*</td>
<td>.41**</td>
<td>.64***</td>
<td></td>
<td>.51***</td>
<td></td>
<td>.17</td>
<td>.41*</td>
</tr>
<tr>
<td>T1 COP</td>
<td>.15</td>
<td>.03</td>
<td>.16</td>
<td>.17</td>
<td>.25</td>
<td>.29*</td>
<td></td>
<td>.13</td>
<td></td>
<td>.24</td>
</tr>
<tr>
<td>T2 CCR</td>
<td>.05</td>
<td>.20</td>
<td>.12</td>
<td>.59***</td>
<td>.47*</td>
<td>.24</td>
<td>.43*</td>
<td>.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T2 COV</td>
<td>.18</td>
<td>.01</td>
<td>.22</td>
<td>.41**</td>
<td>.60***</td>
<td>.25</td>
<td>.49*</td>
<td>.12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note.*** p < .001; ** p < .01; * p < .05. T1 = Time 1; T2 = Time 2. ME = Maternal Education; NR = Nonverbal Reasoning; CCR = Chinese Character Reading; COV = Chinese Oral Vocabulary; CPA = Chinese Phonological Awareness; CCM = Chinese Compound Awareness; COP = Chinese Orthographic Processing.*
To confirm my observation that the same relational patterns exist between two age groups, tests of homogeneity of variance-covariance matrices were conducted separately on the English and Chinese measures using Box’s M test, available in SPSS Discriminant Analysis. The results of Box’s M tests showed no significant difference in variance-covariance patterns between the two age groups on the English measures, $Box's M = 84.59, F(55, 17091) = 1.147, p = .213$, or the Chinese measures, $Box's M = 71.98, F(55, 17091) = 1.139, p = .224$. Therefore, the two groups were combined for the following analyses.

**Path analysis.**

Based on these within-language correlations, I performed path analysis using AMOS 18 on English and Chinese separately to examine in each language to what extent the three component skills, i.e., phonological awareness, morphological awareness and orthographic processing, concurrently and longitudinally contributed to early literacy skills, i.e. word reading and oral vocabulary. Including all three skills in one model allowed me to examine the independent contribution of each skill after the other two were controlled at the same time. Path analysis allowed an examination involving more than one outcome variable, in my case both reading and vocabulary; it also controlled covariance among measures, and provided fitting indices to show how well the models statistically represent the data, which were not available in the multiple regressions most other studies employed.

First, I constructed two parallel baseline path diagrams, one for each language. Here I only describe the English diagram in detail; the Chinese diagram had exactly the same hypothesized relationships. The English diagram included Time 1 English phonological awareness, morphological awareness, and orthographic processing, and also Time 1 and Time 2 English word reading and oral vocabulary. It was hypothesized that all three Time 1
metalinguistic skills (phonological awareness, morphological awareness, and orthographic processing) would concurrently predict Time 1 reading and longitudinally predict Time 2 reading after the autoregressor of reading at Time 1 was controlled, while the two oral component skills (phonological awareness and morphological awareness) concurrently predicted Time 1 vocabulary and Time 2 vocabulary beyond the autoregressive effect of Time 1 vocabulary. Among the four outcome variables (Time 1 and Time 2 word reading and oral vocabulary), Time 1 reading was hypothesized to predict Time 2 reading and vocabulary; Time 1 vocabulary predicted Time 2 reading and vocabulary; and vocabulary at each time point predicted reading concurrently. Given that phonological awareness, morphological awareness and orthographic processing are conceptualized as three interrelated component skills (Plaut et al., 1996; Seidenberg & McClelland, 1989), they were also covariates for each other. The decision on what would be used as the controlled variable(s) for children’s general developmental and nonverbal abilities were based on preliminary analyses on the relationship among related variables, such as age, nonverbal reasoning, grade, and maternal education. Nonverbal reasoning was the best predictors to the key variables of interests (phonological awareness, morphological awareness, orthographic processing, word-level reading and oral vocabulary) for both Chinese and English in the study. Age, grade, or maternal education did not contributed additional variances to these key variables in Chinese and English beyond the contribution of nonverbal abilities. Therefore, given the limited sample size, nonverbal reasoning was used as the only but the most efficient control of general abilities in the path models. To simplify presentations, it is not depicted in any of the following figures.

Figure 1 and Figure 2 depict the baseline path diagrams with all hypothesized covariate and regression paths, for English and Chinese, respectively. All the solid lines illustrate
concurrent relationships and the dashed line represents longitudinal relationships. Within each language, several questions were of interest: (a) To what extent do phonological awareness, morphological awareness, and orthographic processing independently predict word-level reading and/or oral vocabulary concurrently? (b) To what extent do these skills longitudinally predict word-level reading and/or oral vocabulary above and beyond the effect of the concurrent reading and vocabulary? (c) What are the concurrent and longitudinal relationship between word-level reading and oral vocabulary, the two literacy outcomes?

These baseline models were then estimated and modified to achieve optimization, with two important criteria: (a) the model remains a good fit for the data; and (b) the model is most parsimonious, that is, it has the fewest parameters for an acceptable fit. The goodness-of-fit of each model was assessed using multiple indices as suggested by many researchers (Browne & Cudeck, 1993; Schumacker & Lomax, 2004). The most commonly used fitting indices included the chi-square, goodness-of-fit index (GFI), comparative fit index (CFI), and root mean squared error of approximation (RMSEA). A good model fit is assumed when the chi-square is not significant, the GFI and CFI are greater than .95, and the value for RMSEA is smaller than .05 (Schumacker & Lomax, 2004). RMSEA values below or at .05 indicate a close fit but values as high as .07 are regarded as acceptable (Browne & Cudeck, 1993).

To have confidence in the goodness of fit test, a sample size of 100 to 200 is recommended (Hoyle, 1995). A model, in general, should contain 10 to 20 times as many observations as variables (Mitchell, 1993), and the ratio of sample size to the number of free parameters should be at least 5:1 (Bentler, 1989). The current study marginally met these requirements in that the sample size was approaching 100 and the ratio of observations to variables in the hypothesized model was 91/8, over 11. To estimate the model fit, General Least
Squares (GLS) was selected; Hu, Bentler, and Kono (1992) suggested that when the sample size was less than 500, GLS was slightly a better choice than the other two commonly used estimation methods, Maximum Likelihood (ML) and Scaled ML.

*Figure 1.* The baseline model for English. T1 = Time 1; T2 = Time 2; EPA = English Phonological Awareness; EMA = English Morphological Awareness (Derivational); EOP = English Orthographic Processing; EOV = English Oral Vocabulary; EWR = English Word Reading. Solid lines illustrate concurrent relationships while dashed lines represent longitudinal relationships.
Figure 2. The baseline model for Chinese. T1 = Time 1; T2 = Time 2; CPA = Chinese Phonological Awareness; CMA = Chinese Morphological Awareness (Compound); COP = Chinese Orthographic Processing; COV = Chinese Oral Vocabulary; CCR = Chinese Character Reading. Solid lines illustrate concurrent relationships while dashed lines represent longitudinal relationships.

Estimation and modification for the English model.

The baseline model for English was first estimated. The results demonstrated a very good model fit, $\chi^2 (2) = 1.91, p = .385$, CFI = .99, GFI = .99, RMSE = .03. The model did not show any offending estimates, but contained several non-significant regression and covariate coefficients, suggesting the need for modification. The model was then modified through two procedures, the Lagrange Multiplier Index (LM) and the Wald test. The results of the first procedure were available in Modification Indices of the AMOS 18, which suggested no modification is needed through adding any parameter(s). The Wald test was then conducted manually to investigate whether deletion of free parameters would increase model fitness. A low
probability value (p < .01) was employed when removing parameters in order to adjust for increased Type I error rates (Ullman, 2007).

To achieve the most parsimonious model, nonsignificant regression and covariance paths were taken out one at a time until all remaining paths were significant. Deletion of nonsignificant paths followed an order from longitudinal relationships, to covariances, and then to concurrent predictions until the remaining coefficients in the model were all significant and there was no significant change of goodness-of-fit from the baseline model. Every step of deletion was guided by the Wald test using the Chi-square change index. The most parsimonious model showed a good model fit too, $\chi^2 (15) = 20.90$, $p = .140$, CFI = .98, GFI = .95, RMSE = .05. Most importantly, the Walt test of model comparison suggested a nonsignificant Chi-square change from the baseline model, $\Delta \chi^2 (13) = 19$, $p = .123$, suggesting that, even with fewer parameters, the most parsimonious model fit as well as the baseline model. Therefore, this model was considered final for depicting within-language relationships for English. Figure 3 provides the graphic presentation of the final English model.

Table 5 summarizes the standardized parameters ($\beta$) and the unique variances ($\Delta R^2$) of the dependent variables, i.e., Time 1 and Time 2 word reading and oral vocabulary, explained by relevant significant contributors for English. The results indicated that Time 1 phonological awareness, morphological awareness and orthographic processing uniquely contributed 18%, 3%, and 18% of the variances, respectively, to Time 1 word reading. Time 1 word reading and oral vocabulary were significant predictors of Time 2 corresponding measures, accounting for 48% and 4% of the variances, respectively. Time 1 morphological awareness was a concurrent and also a longitudinal contributor of oral vocabulary, accounting for 21% and 13% of the variances.
Figure 3. The final English model, showing the standardized coefficients. T1 = Time 1; T2 = Time 2; EPA = English Phonological Awareness; EMA = English Morphological Awareness (Derivational); EOP = English Orthographic Processing; EOV = English Oral Vocabulary; EWR = English Word Reading. *** $p < .001$; ** $p < .01$; * $p < .05$. Solid lines illustrate concurrent relationships while dashed lines represent longitudinal relationships. $N= 91$. 
Table 5

*Standardized Coefficients (β) and Unique Variances (ΔR²) Explained in the Final English Model.*

<table>
<thead>
<tr>
<th>Variables</th>
<th>β</th>
<th>ΔR²</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>T1 English Word Reading</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1 English Phonological Awareness</td>
<td>.42</td>
<td>.18***</td>
</tr>
<tr>
<td>T1 English Morphological Awareness</td>
<td>.18</td>
<td>.03*</td>
</tr>
<tr>
<td>T1 English Orthographic Processing</td>
<td>.42</td>
<td>.18***</td>
</tr>
<tr>
<td><strong>T2 English Word Reading</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1 English Word Reading</td>
<td>.69</td>
<td>.48***</td>
</tr>
<tr>
<td><strong>T1 English Oral Vocabulary</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1 English Morphological Awareness</td>
<td>.46</td>
<td>.21***</td>
</tr>
<tr>
<td><strong>T2 English Oral Vocabulary</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1 English Morphological Awareness</td>
<td>.36</td>
<td>.13**</td>
</tr>
<tr>
<td>T1 English Oral Vocabulary</td>
<td>.20</td>
<td>.04*</td>
</tr>
</tbody>
</table>

*Note.* ***p < .001; **p < .01; *p < .05. N= 91.
Estimation and modification for the Chinese model.

A similar procedure was used to estimate and modify the Chinese model. The goodness-of-fit index of the baseline Chinese model was not optimal, but at an acceptable level, $\chi^2(2) = 4.93$, $p = .085$, CFI = .99, GFI = .99, RMSE = .08. No modification was suggested by the AMOS program for adding any parameter(s). Then, the Walt test was performed to free parameters one by one to achieve the most parsimonious model. In the end, the final model maintained a good model fit, $\chi^2(17) = 23.10$, $p = .146$, CFI = .98, GFI = .95, RMSE = .05, and when compared to the baseline model, it was no different in terms of fitness, $\Delta\chi^2(15) = 18.17$, $p = .254$. Figure 4 depicts the final Chinese model.

Table 6 details the standardized coefficients ($\beta$) and the unique variances ($\Delta R^2$) of the significant predictions in the Chinese language. For Chinese, only Time 1 morphological awareness contributed 14% and 45% of the variances in Time 1 character reading and oral vocabulary, which in turn predicted 7% and 23% of the variances in corresponding measures at Time 2. Interestingly, Time 2 vocabulary uniquely explained 27% of the variances in Time 2 character reading.

The English and Chinese models demonstrated differentiated within-language relationships. While all three component skills concurrently contributed to word-level reading skills in English, only morphological awareness predicted character reading in Chinese. The Chinese model demonstrated a strong relationship between oral vocabulary and reading, whereas there was a lack of such an association for English. Despite these differences, there were some similarities. For both languages, morphological awareness significantly predicted oral vocabulary concurrently. The strongest predictors of Time 2 reading and vocabulary were their autoregressors.
Figure 4. The final Chinese model, showing the standardized coefficients. T1 = Time 1; T2 = Time 2; CPA = Chinese Phonological Awareness; CMA = Chinese Morphological Awareness (Compound); COP = Chinese Orthographic Processing; COV = Chinese Oral Vocabulary; CCR = Chinese Character Reading. *** p < .001; ** p < .01; * p < .05. Solid lines illustrate concurrent relationships while dashed lines represent longitudinal relationships. N= 91.
Table 6

*Standardized Coefficients (β) and Unique Variances (ΔR²) Explained in the Chinese Model.*

<table>
<thead>
<tr>
<th>Variables</th>
<th>β</th>
<th>ΔR²</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>T1 Chinese Character Reading</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1 Chinese Morphological Awareness</td>
<td>.37</td>
<td>.14**</td>
</tr>
<tr>
<td><strong>T2 Chinese Character Reading</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1 Chinese Character Reading</td>
<td>.26</td>
<td>.07*</td>
</tr>
<tr>
<td>T2 Chinese Oral Vocabulary</td>
<td>.52</td>
<td>.27***</td>
</tr>
<tr>
<td><strong>T1 Chinese Oral Vocabulary</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1 Chinese Morphological Awareness</td>
<td>.67</td>
<td>.45***</td>
</tr>
<tr>
<td><strong>T2 Chinese Oral Vocabulary</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1 Chinese Oral Vocabulary</td>
<td>.57</td>
<td>.32***</td>
</tr>
</tbody>
</table>

*Note.*** p < .001; ** p < .01; * p < .05. N= 91*
Discussion

Study 1 was designed to investigate the concurrent and longitudinal predictions of three component skills, namely phonological awareness, morphological awareness and orthographic processing, to two fundamental literacy abilities, word-level reading and oral vocabulary, in both Chinese and English among young Chinese-English bilingual children. Through comparing and contrasting these predictive patterns between Chinese and English, the primary goal of this study was to understand similar/dissimilar cognitive/metalinguistic demands of developing early literacy skills between the two languages for bilingual children. In the following sections, I will first discuss the results regarding English reading and Chinese reading separately, and then the similarities and differences between the two.

How important are the three component skills for concurrent and longitudinal literacy skills in English?

With regard to English, one important finding was that all three component skills—phonological awareness, morphological awareness and orthographic processing—were significant unique predictors of concurrent English word reading skills. These predictions were unique in the sense that all three skills were included in one model and the contribution of each skill to English word reading was beyond the influence of the other two and their intercorrelations. The individual contributions of these skills to word reading have been well documented through separate empirical investigations (for phonological awareness: Adams, 1990; Bradley & Bryant, 1983; Bryant, MacLean, Bradley, & Crossland, 1990; Stanovich, 1986, 1992; Wagner & Torgesen, 1987; for morphological awareness: Carlisle, 1995; Carlisle & Nomanbhoy, 1993; Deacon & Kirby, 2004; Fowler & Liberman, 1995; Mahony, Singson, & Mann, 2000; Singson, Mahony, & Mann, 2000; and for orthographic processing: Barker et al.,
Phonological, morphological and orthographic processing, however, have been conceptualized as three interactive processes involved in visual word recognition (Plaut et al., 1996; Seidenberg & McClelland, 1989), which may represent distinctive processes with shared resources. It has been a pressing issue to theoretically understand and empirically test the independent contributions of these skills towards word reading. The unique contributions of these skills identified in the present study exactly demonstrated such distinctiveness, or in other words predictive independence. Specifically, the study showed that phonological awareness, morphological awareness, and orthographic processing uniquely explained 18%, 3% and 18% of the variances, respectively, in concurrent English word reading abilities.

These results extended those based on monolingual English-speaking children (Deacon, in press), revealing remarkably similar patterns. Deacon showed that, for Grade 1 and Grade 3 monolingual English-speakers, phonological awareness, morphological awareness and orthographic processing made independent contributions to real word reading, respectively explaining 7%, 1%, and 10% of the variances in the outcome variable. The findings from both studies indicated that all three skills independently contribute to word reading, suggesting that, for both monolingual and bilingual children, these skills represented three distinctive constructs important for learning to read words in English. Nevertheless, the unique variances explained by the three skills were consistently larger for bilingual children in the current study than for monolingual children studied by Deacon (in press). Such difference might be largely due to the bilingual status of this group of children. To them, reading may be a more cognitively demanding task, and as a result, may be more dependent on the underlying cognitive and
metalinguistic abilities captured in phonological awareness, morphological awareness and orthographic processing (Geva & Siegel, 2000).

The two studies also showed that the contributions of phonological awareness and orthographic processing to English word reading were larger than those of morphological awareness. Deacon (in press) did not provide an explanation for such differences. Nonetheless, the current study suggested a promising account in light of the ‘Simple View of Reading’ (Gough & Tunmer, 1986, 1986; Hoover & Gough, 1990), a model discussed at the very beginning of this thesis. In this model, early literacy skills are not limited to word reading skills; instead, it also includes oral language proficiency for developing optimal reading comprehension abilities. Given that kindergarten and Grade 1 children are yet to develop reading comprehension abilities to be reliably measured, the current study, based on the simple view of reading model, assessed children’s word-level reading ability and oral vocabulary (an index of oral proficiency) as two important early literacy outcomes. While morphological awareness was found to predict a very small amount of unique variance in word reading, it was the dominant predictor of oral vocabulary.

Specifically, morphological awareness explained 21% of the unique variance in concurrent English oral vocabulary, and further predicted 13% of the unique variance even after Time 1 English oral vocabulary was controlled. In fact, some studies have demonstrated the importance of morphological awareness in acquiring vocabulary knowledge (e.g., McBride-Chang et al., 2005; Nagy, Berninger, & Abbott, 2006); and others focused on the role of morphological awareness in word reading (e.g., Carlisle, 1995; Carlisle & Nomanbhoj, 1993; Deacon & Kirby, 2004; Fowler & Liberman, 1995; Mahony, Singson, & Mann, 2000; Singson, Mahony, & Mann, 2000). This study is, nevertheless, the first that has compared the
contributions of morphological awareness to the two fundamental literacy skills. As shown, different component skills may contribute to different aspects of literacy abilities in that morphological awareness was more important for the development of vocabulary knowledge; whereas, in comparison, phonological awareness and orthographic processing were more important for developing word reading abilities. This finding can be used to explain why morphological awareness accounted for less unique variance than the other two component skills in Deacon (in press), where a measure of vocabulary was included in the model as general abilities, and therefore, a large amount of variance in literacy abilities that morphological awareness could explain had been removed.

Moreover, this study also examined the longitudinal prediction of the three component skills with respect to literacy outcomes one year later, with the control of auto-regressive effects of Time 1 literacy skills. All three component skills concurrently predicted word reading skills, but none of them uniquely predicted Time 2 word reading when Time 1 reading was controlled in the model. The auto-regressive effect was very strong, with Time 1 word reading explaining 48% of variances in Time 2 word reading, and completely mediating any longitudinal effects of the components skills on word reading measured one year later. Including auto-regressive controls in the model is a stringent test of longitudinal effects. Unique longitudinal contributions beyond auto-regressive effects are interpreted as the evidence that the predicting skills causally determine the development of outcome skills (e.g., Deacon, Benere, & Castles, 2012; Wagner et al., 1994), or as a technique to evaluate the contributions of the predictors to “unexpected growth” in the outcome variables (Manis, Seidenberg, & Doi, 1999, p. 148). Previous investigations have mostly focused on one of the three component skills and its longitudinal effects on word-level reading, and have demonstrated some evidence that phonological
awareness (e.g., Manis et al., 1999), morphological awareness (e.g., Deacon & Kirby, 2004), and orthographic processing (e.g., Cunningham et al., 2001) made unique longitudinal contributions to word-level reading after controlling for the auto-regressive effects. However, when three metalinguistic constructs were included in the same model to test their independent role in word-level reading, this study did not find unique predictions by any of the three constructs of subsequent word reading beyond the auto-regressive contribution. A lack of unique longitudinal prediction in the current research may be due to the fact that all three component skills were included in the model, and therefore, what was evaluated was the unique longitudinal contribution of one skill (e.g., phonological awareness) to word-level reading after controlling for the contributions of the other two (e.g., morphological awareness and orthographic processing). Such a hypothesis needs to be further tested on another sample.

With regard to the longitudinal contributions of component skills to oral vocabulary, the finding was that Time 1 morphological awareness uniquely predicted Time 2 oral vocabulary (13%) beyond the auto-regressive effect of Time 1 oral vocabulary. However, the auto-regressive effect only accounted for about 4% of variance in Time 2 oral vocabulary, which was due to the low correlation between Time 1 and Time 2 English oral vocabulary. This low correlation may be attributed to relatively low sample reliabilities on the oral vocabulary measure, Cronbach’s $\alpha = .54$ and .64 for Time 1 and Time 2, respectively. This has been one of few studies that aimed to tackle the longitudinal effects of metalinguistic skills on oral vocabulary. Even though a promising result, the unique longitudinal prediction of morphological awareness on oral vocabulary needs to be replicated in a future study.

Another interesting finding for English was that English vocabulary and word reading were not related with each other at each time point, nor longitudinally. This result was in line
with the theorization of the ‘Simple View of Reading’, which treats decoding (measured with word reading in this study) and linguistic comprehension (measured with oral vocabulary in the study) as two distinctive constructs accounting for reading comprehension. According to Hoover and Gough’s observation, “the correlations between decoding and listening comprehension tended to become negative as samples were successively restricted to less skilled readers” (1990, p. 127). This certainly applies to our sample, composed of kindergarten and Grade 1 children who had just started to develop reading skills. This finding also echoed several other studies that reported similar observation of a low correlation between the two constructs (e.g., Georgiou et al., 2009; Savage, 2001).

**How important are the three component skills for concurrent and longitudinal literacy skills in Chinese?**

With regard to Chinese reading, the concurrent and longitudinal prediction of the component skills for character reading and oral vocabulary demonstrated different patterns. Among the three skills, Chinese compound morphological awareness was the only one that uniquely predicted character reading and oral vocabulary concurrently, explaining 14% and 45% of unique variance, respectively. Similar to English, morphological awareness was a stronger predictor of oral vocabulary than word reading. It seems surprising to find that phonological awareness did not predict literacy outcomes, particularly character reading abilities. Many studies have demonstrated and argued that phonological awareness is a universal predictor of word-reading skills across languages, even for a logographic language like Chinese (Ho & Bryant, 1997b; Hu & Catts, 1998; McBride-Chang & Ho, 2000; Siok & Fletcher, 2001). But a closer examination reveals several explanations for such a finding. First, previous studies that exclusively focused on the role of phonological awareness in Chinese character reading only
controlled several general cognitive skills, such as nonverbal abilities, maternal education, visual skills, rapid automatized naming, verbal memory and sometimes also orthographic processing (Ho & Bryant, 1997b; Hu & Catts, 1998; McBride-Chang & Ho, 2000; Siok & Fletcher, 2001). In general, these studies reported a unique contribution of phonological awareness to character reading beyond the controlled general abilities. However, this study also included morphological awareness in the prediction. The results further indicated that, in comparison to morphological awareness, phonological awareness had less of an effect on character reading. This result was consistent with a handful of studies that compared the relative contributions of morphological awareness and phonological awareness to Chinese reading in monolingual children. For example, McBride-Chang et al. (2005) examined relations among phonological awareness, morphological awareness, vocabulary, and word recognition across languages in Beijing, Hong Kong, Korea, and the United States, and found morphological awareness to be more important for reading in Chinese and Korean than for reading in English, while phonological awareness was more important for reading in English and Korean than for reading in Chinese. Tong and McBride-Chang (2010) investigated the roles of sub-character processing, phonological awareness, morphological awareness, and orthographic knowledge in Chinese word reading among Hong Kong children, and found that visual-orthographic skills and morphological awareness, but not phonological awareness, were uniquely associated with Chinese character recognition, with age and nonverbal IQ statistically controlled.

Another explanation of the non-significant contribution of phonological awareness to Chinese character reading lies in the fact that the development of phonological awareness is influenced by linguistic contexts, and associated linguistic and instructional experiences. Of particular relevance for this sample is their bilingual experience. Some researchers have argued
that bilingualism itself promotes heightened sensitivity to phonological structures of both languages. Our sample of Chinese-English bilingual children may have developed more advanced sensitivity to phonological structures in Chinese as compared to children in China (e.g., Lam, Chen, Geva, Luo, & Li, 2011; Marinova-Todd, Zhao, & Bernhardt, 2010). As a result, such advanced phonological skills may have surpassed a threshold in predicting reading in Chinese. In a sense, the Chinese-English bilingual children have developed phonological awareness to a level that is more than what is needed for developing early character reading abilities. Weak relationships between phonological awareness and character reading were also documented in several other studies on Chinese-English bilingual children in North America (e.g., Gottardo et al., 2001, 2006; M. Wang et al., 2005), with nonsignificant zero-order correlations between phonological awareness and character reading measures.

Another surprising finding is that orthographic processing was not predictive of character reading, which is opposite to general findings of the relationship in other studies (e.g., Ho et al., 2002, 2004, 2007; McBride-Chang & Ho, 2005). For example, McBride-Chang and Ho (2005) reported that orthographic processing is a unique cognitive predictor of Chinese character recognition, but in comparison, it is not as important in English word reading. Research on Chinese dyslexic children has suggested that orthographic processing is the most dominant cognitive deficit in Chinese developmental dyslexia (e.g., Ho et al., 2002, 2004, 2007). One reason for the nonsignificant prediction revealed in the current study is likely due to the low reliability of the orthographic processing measure; Cronbach’s $\alpha$ was only .32. The same measure achieved a much higher reliability among monolingual Chinese children, Cronbach’s $\alpha = .59$ or .71 (Luo, Chen, Deacon, & Li, 2011). The extremely low reliability is likely attributed to the very limited print exposure that Chinese-bilingual children may have in an English dominant
environment. Unlike those in a Chinese dominant environment who have been exposed to the Chinese writing system informally through environmental print, children in an English environment may have not been exposed to Chinese print before learning to read Chinese characters. A more sensitive measure is needed to capture orthographic processing skills among children with limited Chinese print experience.

Interestingly, the relationships among Chinese measures showed that Chinese oral vocabulary and Chinese character reading were strongly related to each other. Specifically, Chinese oral vocabulary explained 27% of the variance in character reading concurrently at Time 2. This finding is contrasted with the non-significant relationship between the two measures in English, and raises two questions requiring further investigation. First, can the observed relationship be attributed to the typology of the language under study? In other words, does learning to read Chinese require more vocabulary knowledge, in comparison to English, as a way to enhance the lexical quality in character/word recognition? Oral vocabulary is a representation of the sound and meaning of oral words, and a larger vocabulary may be associated with a higher probability of recruiting word information (in the aspects of sound and meaning) available in the mental lexicon into learning to read new words. English word recognition is facilitated by rather reliable grapheme-phoneme correspondences, whereas Chinese lacks such a system and as a result, character learning may benefit more from the access of the sound and meaning of words in oral language. Or otherwise, is the strong relationship between vocabulary and reading in Chinese a result of the Chinese-English children’s particular linguistic experiences in which oral language and reading skills develop simultaneously? Even though these children learned Chinese as their mother tongue, English quickly became their dominant language as soon as they started daycare or school (Kouritzin, 1999; Wong-Fillmore, 1991). In the situation of simultaneous
development of oral language and vocabulary, there may be a strong association between the two as an indication of general language abilities or exposure to that language. These hypotheses need to be tested in future studies.

Taken together, relationships in English and Chinese reading among Chinese-English bilingual children suggest that early literacy development in the two languages has differentiated cognitive and metalinguistic demands. The roles of phonological awareness, morphological awareness and orthographic processing in English word reading for this group of bilinguals are similar to those of monolingual children (Deacon, in press), with all three skills uniquely contributing towards word reading abilities. In contrast, Chinese character reading seems to rely predominantly on morphological awareness. Similar patterns emerge across languages. In both Chinese and English, morphological awareness was more important for oral vocabulary than for word reading. Additionally, Time 1 component skills did not contribute to Time 2 literacy outcomes uniquely after Time 1 autoregressors of these outcome variables were controlled.
CHAPTER 7. STUDY TWO

Participants

The participants in this study were the same as in Study 1: 91 Chinese-English speaking bilingual children. Study 1 focused on within-language relationships among measures of interest in English and Chinese separately, whereas Study 2 examined cross-linguistic relationships between literacy skills in the two languages. Analyses based on the same sample allowed easy interpretation and comparison of the within and between-language patterns. More details about the participants can be found in the Method chapter.

Measures

The measures included in Study 2 were maternal education and nonverbal reasoning, phonological awareness, and compound morphological awareness measured at Time 1, and word-level reading and oral vocabulary measured at both Time 1 and Time 2 in English and Chinese. It should be noted that, in this study, compound morphological awareness was used as the measure of morphological awareness in both English and Chinese for the examination of cross-language relationships. Detailed descriptions of these measures are also provided in the Method chapter.

Results

Descriptive statistics.

Table 7 reports means, standard derivations, and score ranges of maternal education, nonverbal reasoning, phonological awareness, and compound morphological awareness measured at Time 1, and word-level reading and oral vocabulary measured at both Time 1 and
Time 2 in English and Chinese for children in kindergarten and Grade 1, as well as for the combined group. Sample reliabilities (Cronbach’s alphas) based on the combined groups are also reported for all measures (except for maternal education) in Table 7. For all measures, raw scores are presented. The skewness and kurtosis of the raw scores were both within a reasonable range, -1.158 ≤ skewness ≤ 1.852 and -2.477 ≤ kurtosis ≤ 2.5. Thus, the assumption of normal distribution was satisfied.

I first performed a test of homogeneity of variance-covariance matrices with Box’s M test, using Discriminant Analysis to compare the relational patterns among the English and Chinese measures between children in kindergarten and Grade 1 groups. The results of the Box’s M tests showed no significant difference in variance-covariance patterns between the two grades on the Chinese and English measures, Box’s M = 267.06, F(171, 16296) = 1.20, p = .96. The non-significant results showed that the correlational patterns in the two grades were similar. Therefore, the two grades were combined for further analysis. Table 8 presents the correlations among the English and Chinese measures for the combined group.

The correlation results suggested that phonological awareness measured in the two languages was moderately correlated, r = .67, p < .001; so was compound morphological awareness in the two languages, r = .67, p < .001. Word-level reading in English and Chinese demonstrated small but significant correlations concurrently at Time 1, rs = .31, ps < .05, and longitudinally between both Time 1 English and Time 2 Chinese and between Time 1 Chinese and Time 2 English, rs = .25 and .24, ps < .05. However, scores on English and Chinese oral vocabulary were not correlated either concurrently or longitudinally.

Cross-linguistic relationships were observed from Chinese component skills to English literacy outcomes, and from English component skills to Chinese literacy outcomes. Time 1
English phonological awareness was correlated with Time 1 Chinese reading, \( r = .23, ps < .05 \), and Time 1 English compound awareness was correlated with Time 1 Chinese vocabulary and reading, \( r = .44 \) and \( .28, ps < .05 \). Moreover, Time 1 Chinese phonological awareness was correlated with Time 1 English vocabulary and reading, \( r = .28 \) and \( .67, ps < .05 \), and Time 2 English vocabulary and reading, \( r = .28 \) and \( .50, ps < .05 \). Also, Time 1 Chinese compound awareness was related to Time 1 English word reading, \( r = .42, ps < .01 \), and Time 2 English vocabulary and reading, \( r = .22 \) and \( .30, ps < .05 \).
Table 7

*Means and Standard Derivations of the Measures by Grade.*

<table>
<thead>
<tr>
<th>Measures</th>
<th>Min-Max</th>
<th>Sample Reliability Cronbach’s α</th>
<th>Kindergarten cohort (n=56)</th>
<th>Grade 1 cohort (n=35)</th>
<th>Combined (N=91)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>Maternal Education</td>
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<td>4.89</td>
<td>0.97</td>
<td>4.89</td>
</tr>
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<td>14.84</td>
<td>3.74</td>
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<td><strong>English Measures</strong></td>
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<td></td>
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<td>4.09</td>
<td>3.78</td>
<td>9.63</td>
</tr>
<tr>
<td>T1 English Compound Awareness</td>
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<td>5.31</td>
<td>3.63</td>
<td>8.77</td>
</tr>
<tr>
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<td>32.46</td>
<td>4.49</td>
<td>33.83</td>
</tr>
<tr>
<td>T1 English Word Reading</td>
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<td>36.78</td>
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<tr>
<td>T2 English Oral Vocabulary</td>
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<td>31.01</td>
<td>6.15</td>
<td>33.89</td>
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<td>T2 English Word Reading</td>
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<td>34.93</td>
<td>12.46</td>
<td>43.53</td>
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<tr>
<td><strong>Chinese Measures</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>T1 Chinese Phonological Awareness</td>
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<td>10.11</td>
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<td>17.89</td>
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<td>7.87</td>
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<td>136.20</td>
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<td>T2 Chinese Character Reading</td>
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<td>.97</td>
<td>25.76</td>
<td>21.17</td>
<td>31.95</td>
</tr>
</tbody>
</table>

*Note. T1 = Time; T2 = Time 2. N= 91.*
Table 8

**Zero Order Correlation Matrices among the English Measures for the Combined Group.**

<table>
<thead>
<tr>
<th>Measures</th>
<th>Age</th>
<th>ME</th>
<th>NR</th>
<th>T1 EPA</th>
<th>T1 ECA</th>
<th>T1 EOV</th>
<th>T1 EWR</th>
<th>T2 EOV</th>
<th>T2 EWR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>—</td>
<td>.07</td>
<td>.63***</td>
<td>.54***</td>
<td>.49**</td>
<td>.20</td>
<td>.58***</td>
<td>.26*</td>
<td>.35**</td>
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<td>ME</td>
<td>-.07</td>
<td>—</td>
<td>.13</td>
<td>.24*</td>
<td>.21*</td>
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<td>.25*</td>
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<td>.25*</td>
</tr>
<tr>
<td>NR</td>
<td>.63***</td>
<td>.13</td>
<td>—</td>
<td>.44**</td>
<td>.55***</td>
<td>.14</td>
<td>.46**</td>
<td>.18</td>
<td>.31*</td>
</tr>
<tr>
<td>T1 CPA</td>
<td>.63***</td>
<td>.17</td>
<td>.55***</td>
<td>.67***</td>
<td>.56**</td>
<td>.28*</td>
<td>.67***</td>
<td>.28*</td>
<td>.50***</td>
</tr>
<tr>
<td>T1 CCA</td>
<td>.50***</td>
<td>.20</td>
<td>.53***</td>
<td>.44**</td>
<td>.62***</td>
<td>.06</td>
<td>.42**</td>
<td>.22*</td>
<td>.30*</td>
</tr>
<tr>
<td>T1 COV</td>
<td>.37**</td>
<td>.25*</td>
<td>.47**</td>
<td>.17</td>
<td>.44**</td>
<td>-.07</td>
<td>.32**</td>
<td>.22*</td>
<td>.29*</td>
</tr>
<tr>
<td>T1 CCR</td>
<td>.37**</td>
<td>.06</td>
<td>.30*</td>
<td>.23*</td>
<td>.28*</td>
<td>.07</td>
<td>.31*</td>
<td>.01</td>
<td>.24</td>
</tr>
<tr>
<td>T2 COV</td>
<td>.22*</td>
<td>.03</td>
<td>.20</td>
<td>.08</td>
<td>.16</td>
<td>-.19</td>
<td>.10</td>
<td>.00</td>
<td>-.14</td>
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*Note.* ***$p < .001$; **$p < .01$; *$p < .05$. T1 = Time 1; T2 = Time 2. ME = Maternal Education; NR = Nonverbal Reasoning; EPA = English Phonological Awareness; ECA = English Compound Awareness; EOV = English Oral Vocabulary; EWR = English Word Reading; CPA = Chinese Phonological Awareness; CCA = Chinese Compound Awareness; COV = Chinese Oral Vocabulary; CCR = Chinese Character Reading. $N = 91$. 
I performed a path analysis using AMOS 18 to further examine transfer between parallel constructs across the two languages, and the direct and indirect cross-language effects of PA and MA on vocabulary and reading. I created two baseline models. One models (Figure 5) examined the concurrent and longitudinal English-to-Chinese predictions. In the model, English phonological and compound awareness at Time 1 were hypothesized to contribute to the parallel Chinese measures at Time 1, which in turn predicted Time 1 Chinese character reading and Chinese oral vocabulary and then Time 2 Chinese character reading and vocabulary. Since phonological awareness and morphological awareness are mutually dependent constructs (e.g., Deacon, in press), phonological awareness and morphological awareness in English were modeled to covary with each other, and so were the two measures in Chinese. The two literacy outcomes, i.e., word reading and oral vocabulary, were also modeled to covary with each other at each time points. The other model (Figure 6) examined similar concurrent and longitudinal Chinese-to-English predictions. The construction of the model was similar to the English-to-Chinese model: Time 1 Chinese phonological and compound awareness at Time 1 were hypothesized to contribute to the parallel English measures at Time 1, which in turn predicted Time 1 English word reading and oral vocabulary and then Time 2 English word reading and vocabulary.
Figure 5. The English-to-Chinese baseline model. Dashed lines depict hypothesized covariance while solid lines illustrate hypothesized paths.
Figure 6. The Chinese-to-English baseline model. Dashed lines depict hypothesized covariance while solid lines illustrate hypothesized paths.
Estimation and modification of the English-to-Chinese model.

I first examined the English-to-Chinese prediction (Figure 5). The baseline model was tested and demonstrated an acceptable fit, $\chi^2(16) = 16.65$, $p = .032$, CFI = .98, GFI = .97, RMSEA = .07. The baseline model did not show any unreasonable estimates, but contained several non-significant regression and covariate coefficients, including non-significant regression coefficients between English phonological awareness and Chinese compound awareness, between Chinese phonological awareness and vocabulary or reading, and a covariance coefficient between vocabulary and reading. The Wald test was conducted to remove these non-significant estimates one at a time to achieve the most parsimonious model with equally good fit. With each path deleted, the modified model was compared to the previous model with a chi-square difference test. In each of these steps, the Lagrange Multiplier Index (LM) suggested no free estimate to be added. The most parsimonious model was demonstrated an acceptable model fit, $\chi^2(25) = 34.64$, $p = .031$, CFI = .98, GFI = .95, RMSEA = .06, which fit the data as well as the baseline model, $\Delta \chi^2(6) = 7.98$, $p = .240$.

Based on the most parsimonious model, four alternative models were then hypothesized to examine concurrent direct prediction from Time 1 English phonological awareness or English compound awareness to Time 1 Chinese oral vocabulary or Chinese character reading. The four models respectively added one of the four paths: Time 1 English phonological awareness to Time 1 Chinese oral vocabulary; Time 1 English phonological awareness to Time 1 Chinese character reading; Time 1 English compound awareness to Time 1 Chinese oral vocabulary; and Time 1 English compound awareness to Time 1 Chinese oral vocabulary. The results of the four models were then compared to the most parsimonious model, and showed none of these added
paths were significant, $\beta s \leq .10$, $p s \geq .250$, or significantly improved model fitting, $\Delta \chi^2 s (1) \leq 1.25$, $p s \geq .264$.

Similarly, four alternative models were then hypothesized to examine *longitudinal* direct prediction from Time 1 English phonological awareness or English compound awareness to Time 2 Chinese oral vocabulary or Chinese character reading. The four models respectively added one of the four paths: Time 1 English phonological awareness to Time 2 Chinese oral vocabulary; Time 1 English phonological awareness to Time 2 Chinese character reading; Time 1 English compound awareness to Time 2 Chinese oral vocabulary; and Time 1 English compound awareness to Time 2 Chinese oral vocabulary. When compared to the most parsimonious model, the four models did not gain significantly better fitting to the data, $\Delta \chi^2 s (1) \leq 2.46$, $p s \geq .117$. The added longitudinal paths were not significant either, $\beta s \leq .09$, $p s \geq .111$.

Therefore, the most parsimonious model was the final model depicted in *Error! Reference source not found.* illustrates the final model with standardized coefficients. Table 9 provides the standardized parameter estimates for the final model with direct, indirect and total effects. English compound awareness indirectly affected Chinese reading and vocabulary measured concurrently, $\beta = .16$, and .20. Such an indirect effect operated through Chinese compound awareness, as English compound awareness first significantly predicted Chinese compound awareness, $\beta = .48$, $p < .001$, which in turn significantly contributed to Chinese reading, $\beta = .38$, $p < .01$ and vocabulary, $\beta = .69$, $p < .001$. In contrast, English phonological awareness had neither direct nor indirect cross-linguistic effects on Chinese literacy outcomes.
Figure 7. The Chinese-to-English final model. T1 = Time 1. T2 = Time 2. EPA = English Phonological Awareness; ECA = English Compound Awareness; CPA = Chinese Phonological Awareness; CCA = Chinese Compound Awareness. Dashed lines depict significant covariance while solid lines illustrate significant paths. *** p < .001; ** p < .01; * p < .05. N = 91.
Table 9

Standardized Direct, Indirect, and Total Effects for the English-to-Chinese Model

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Note. *** \(p < .001\); ** \(p < .01\); * \(p < .05\). NR = Nonverbal Reasoning; EPA = English Phonological Awareness; ECA= English Compound Awareness; CPA = Chinese Phonological Awareness; CCA = Chinese Compound Awareness. \(N = 91\).
Estimation and modification of the Chinese-to-English model.

Next, I first examined the Chinese-to-English prediction (Figure 6). The baseline model was tested and demonstrated an acceptable fit, $\chi^2(16) = 28.79, p = .025$, CFI = .97, GFI = .96, RMSEA = .06. The baseline model did not show any unreasonable estimates, but contained several non-significant regression and covariate coefficients, including non-significant relationship between Chinese compound awareness and English phonological awareness, phonological awareness and English oral vocabulary, and also between the two English literacy outcomes. A similar procedure as described for the estimation of the English-to-Chinese model was conducted to remove these non-significant estimates one at a time to achieve the most parsimonious model with equally good fit. The most parsimonious model was demonstrated an acceptable model fit, $\chi^2(22) = 40.41, p = .010$, CFI = .97, GFI = .95, RMSEA = .07, which fit the data as well as the baseline model, $\Delta\chi^2(6) = 11.62, p = .071$.

Based on the most parsimonious model, four alternative models were then hypothesized to examine concurrent direct prediction from Time 1 Chinese metalinguistic skills (phonological and compound awareness) to Time 1 English literacy outcomes (word reading and vocabulary). The four models respectively added one of the four paths: Time 1 Chinese phonological awareness to Time 1 English oral vocabulary; Time 1 Chinese phonological awareness to Time 1 English word reading; Time 1 Chinese compound awareness to Time 1 English oral vocabulary; and Time 1 Chinese compound awareness to Time 1 English oral vocabulary. The results of the four models were then compared to the most parsimonious model. The model with the added path from Time 1 Chinese phonological awareness to Time 1 English word reading had significantly better fit of the data than the parsimonious model, $\Delta\chi^2(1) = 6.94, p = .008$, and the path itself was significant, $\beta = .33, p = .009$. However, the rest of three hypothesized models with
an additional paths did not significantly improved model fit at all, $\Delta \chi^2$s (1) $\leq .98$, $ps \geq .321$, and none of the three added paths were significant, $\beta$s $\leq .10$, $ps \geq .321$.

Similarly, four alternative models were then hypothesized to examine *longitudinal* direct prediction from Time 1 Chinese metalinguistic skills to Time 2 English literacy outcomes. The four models respectively added one of the four paths: Time 1 Chinese phonological awareness to Time 2 English oral vocabulary; Time 1 Chinese phonological awareness to Time 2 English word reading; Time 1 Chinese compound awareness to Time 2 English oral vocabulary; and Time 1 Chinese compound awareness to Time 2 English oral vocabulary. When compared to the most parsimonious model, none of the four models fit better to the data, $\Delta \chi^2$s (1) $\leq 2.39$, $p \geq .122$. The added longitudinal paths were not significant either, $\beta$s $\leq .13$, $ps \geq .122$.

Therefore, the model with an additional path from Time 1 Chinese phonological awareness to Time 1 English word reading was the final model (See *Figure 8*). Table 10 provides the standardized parameter estimates for the final model with direct, indirect and total effects. Concurrently, Chinese phonological awareness predicted English word reading concurrently after nonverbal abilities and compound awareness were controlled, $\beta = .67$, $p < .001$. Such effects included both a direct relationship, $\beta = .33$, $p < .01$ (9% of the variance explained), and an indirect relationship, $\beta = .34$, $p < .01$. The indirect impact was through its effect on parallel Time 1 English phonological awareness, $\beta = .67$, $p < .001$, which then contributed to English word reading abilities, $\beta = .51$, $p < .001$. Longitudinal, Chinese phonological awareness at Time 1 did not directly contributed variance to English word reading at Time 2, instead, this contribution was completely mediated through autoregressive effects.

In comparison, Chinese compound awareness had no cross-language effect on English word reading; and it only had an indirect impact on English oral vocabulary, $\beta = .117$, $p < .05$, \[ \text{Table 10 provides the standardized parameter estimates for the final model with direct, indirect and total effects.} \]
through its effect on English compound awareness, $\beta = .374, p < .001$, and the subsequent effect of English compound awareness on English oral vocabulary, $\beta = .314, p < .01$. Its longitudinal effect on Time 2 English oral vocabulary was also small and indirect, $\beta = .13$. 
Figure 8. The Chinese-to-English model, showing the standardized coefficients. T1 = Time 1. T2 = Time 2. EPA = English Phonological Awareness; ECA= English Compound Awareness; CPA = Chinese Phonological Awareness; EWR = English Word Reading; EOV= English Oral Vocabulary. *** $p < .001$; ** $p < .01$; * $p < .05$. $N = 91$. 
Table 10

*Standardized Direct, Indirect, and Total Effects for the Chinese-to-English Model*

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*Note.* ***p < .001; **p < .01; *p < .05. NR = Nonverbal Reasoning; EPA = English Phonological Awareness; ECA= English Compound Awareness; CPA = Chinese Phonological Awareness; CCA = Chinese Compound Awareness. N = 91.
Discussion

Study 2 was designed to examine cross-language transfer of phonological awareness and morphological awareness to word-level reading and oral vocabulary between Chinese and English among young bilingual children. To directly compare cross-language effects of phonological awareness and morphological awareness, this study adopted path models that included both component skills in the contributing and target languages, as well as word-level reading and oral vocabulary measured concurrently or longitudinally in the target language. In the following section, I will first discuss cross-linguistic effects of phonological awareness and morphological awareness separately, and then compare the similarities and differences between the two.

**Cross-linguistic effects of phonological awareness on word-level reading and vocabulary.**

Study 2 overall supported cross-linguistic transfer of phonological awareness between Chinese and English, two typologically distant languages. First of all, Chinese phonological awareness was predictive of English phonological awareness (20% of the variance) after controlling for non-verbal abilities and Chinese morphological awareness. Similarly, English phonological awareness uniquely predicted Chinese phonological awareness (45% of the variance). As reported and explained in previous transfer studies (e.g., Cisero & Royer, 1995; Comeau et al., 1999; Durgunoğlu et al., 1993; Gottardo et al., 2001; Lafrance & Gottardo, 2005), the unique mutual prediction of phonological awareness between two languages provides evidence for cross-linguistic transfer at this level. Therefore, these findings, consistent with previous studies (e.g., Chow et al., 2005; Gottardo et al., 2001, 2006; M. Wang et al., 2005), suggested that phonological awareness transfers between Chinese and English. In other words,
bilingual children who have good phonological awareness in Chinese are more likely to develop good phonological awareness in English, and vice versa. In essence, children’s understanding that spoken language is composed of smaller phonological units, and the ability to segment these units, are applied to the learning of an additional language.

Of particular interest to this study was, however, to examine cross-linguistic cross-modal effects of phonological awareness on literacy outcomes. The current study focused on both indirect cross-linguistic cross-modal effects of phonological awareness through the mediation of phonological awareness in the target language, and direct effects beyond such mediation. Direct effects are taken as evidence of cross-linguistic cross-modal transfer of a given component skill, which many previous reports of transfer are empirically based on (e.g., Chow et al., 2005; Gottardo et al., 2001, 2006; M. Wang et al., 2005), while the evidence of indirect effects to some extent also suggests a cross-linguistic cross-modal relationship that validates a finding of direct effects and should not be completely ignored in transfer investigations. Two literacy outcomes were included in the study: word-level reading and oral vocabulary. Cross-linguistic cross-modal effects of phonological awareness were examined in relation to the two literacy skills simultaneously within one model. The results regarding to the two literacy outcomes are discussed separately below.

**Cross-linguistic effects of phonological awareness on word-level reading.**

With regard to phonological transfer to word-level reading, the study confirmed previous findings (e.g., Chow et al., 2005; Gottardo et al., 2001, 2006; M. Wang et al., 2005), and suggested that phonological awareness has direct (or unique) cross-linguistic effects on word-level reading in biliteracy development of Chinese and English. It should be noted, however, that the results of the current study were based on a very stringent test with the control of nonverbal
ability, phonological awareness in the target language, and morphological awareness in both the contributing and the target languages. In particular, even though phonological awareness and morphological awareness are two interrelated metalinguistic skills, both contributed independent variance in word-level reading in literacy development among monolingual children (e.g., Deacon, in press; Roman et al., 2009). Therefore, it is theoretically important to test whether there are any independent cross-linguistic cross-modal effects of phonological awareness on word-level reading after partialling out any shared variance between phonological awareness and morphological awareness. This was one of the first studies that explicitly tested and supported such independent cross-linguistic effects.

The study has also produced interesting results regarding the direction of phonological transfer to word-level reading. Specifically, Chinese phonological awareness uniquely predicted English word reading, but no unique prediction was found from English phonological awareness to Chinese character reading. These results were in support of other research based on Chinese-English bilingual children in North America (Gottardo et al., 2006; M. Wang et al., 2005), but differed from the research with bilingual children in the context of Chinese as a dominant language (Chow et al., 2005; Gottardo et al., 2001; Pan et al., 2011). As discussed in the literature review, some researchers suggested that transfer is more likely to occur from a more proficient language to a less proficient language (Deacon et al., 2007), yet this reason is not sufficient to explain the unidirectional Chinese-to-English phonological transfer to word-level reading among Chinese-bilingual children in an English dominant environment, given that these children often had stronger skills in English than in their Chinese heritage language (as explained by Kouritzin, 1999; Wong-Fillmore, 1991). Interestingly, the current study revealed that Chinese phonological awareness was not a significant correlate of Chinese character reading for bilingual
children in an English dominant environment. It was, therefore, not surprising that English phonological awareness was not predictive of Chinese character reading, either. A lack of correlation between Chinese phonological awareness and Chinese character reading was also repeatedly reported in other research based on Chinese-English bilingual children in North America (e.g., Gottardo et al., 2001, 2006; M. Wang et al., 2005). To some extent, these findings suggested that different linguistic contexts or experiences may impose different cognitive/metalinguistic demands for literacy development of a certain language. Consequently, examining the direction of cross-linguistic transfer of a component skill to a literacy outcome requires a consideration of the effects of linguistic contexts (in relation to whether Chinese or English is used as the dominant language in the context) on the within-language relationships between the component skill and the literacy outcome under investigation.

Moreover, the direct contribution of Chinese phonological awareness to English word reading was found, together with evidence of an indirect relationship between the two through the mediation of English phonological awareness. By disentangling the two paths of cross-linguistic effects, this study aimed to answer one fundamental question asked by Selinker (1964) in terms of how transfer occurs. This finding indicates that some resources shared by Chinese and English phonological awareness jointly contributed to learning to read English words. Both Chinese and English phonological awareness measures employed in the current research tapped into syllable and onset (or phoneme) awareness; therefore the shared resources may be sensitivity towards common structures at the syllable and onset (or phoneme) level across the two languages. For example, both languages can be segmented into syllables and further into onset-rime structures. But beyond the shared resources, some unique resources captured in the Chinese, but not English, phonological measure made a unique contribution towards English
word reading as suggested by the direct impact. Such unique resources may be attributed to the opportunity to be exposed to some specific phonological segments in Chinese as contextual variability for phonological awareness across two languages, as explained by Kuo and Anderson (2010).

Beyond the concurrent cross-linguistic relationships discussed above, the present study also examined the unique cross-linguistic effects of phonological awareness on word-level reading longitudinally, after controlling for the effect of parallel phonological constructs in the target language. The findings generally supported an indirect longitudinal cross-language prediction, with Time 1 Chinese phonological awareness predicting Time 2 English word reading ($\beta = .23$) through the mediation of autoregressive effects of Time 1 English word reading. Very few studies have investigated longitudinal effects in cross-linguistic cross-modal transfer. The findings of this study did not support previous investigations (Chow et al., 2005; Pan et al., 2011) most likely due to a more stringent longitudinal effects were examined with controls of metalinguistic skills in both languages and Time 1 word reading and vocabulary as well.

**Cross-linguistic effects of phonological awareness on oral vocabulary.**

The present study also examined cross-linguistic effects of phonological awareness on concurrent and subsequent oral vocabulary, another important literacy skill. The findings indicated that English phonological awareness had no cross-linguistic predictions for either concurrent or subsequent Chinese oral vocabulary; nor was there a prediction from Chinese phonological awareness to English oral vocabulary. This is one of the first studies that have explicitly compared the cross-linguistic transfer of phonological awareness to word-level reading and to oral vocabulary within the same model. Clearly, results of such direct comparison
demonstrated that phonological awareness was cross-linguistically important for word-level reading but not for oral vocabulary, despite the fact that both phonological awareness and oral vocabulary are oral language skills. Research has shown a small but significant within-language contribution of phonological awareness to oral vocabulary in English (e.g., Avons et al., 1998; Bowey, 2001) and Chinese (e.g., Cheung et al., 2010; McBride-Chang et al., 2006). But such phonological awareness developed in one language had minimum cross-linguistic effects on the acquisition of oral vocabulary in the other language among young Chinese-English bilingual children.

**Cross-linguistic effects of compound awareness on word-level reading and vocabulary.**

Similar to the findings for phonological awareness, morphological awareness in Chinese and in English were cross-linguistically predictive of each other. Specifically, English compound awareness was predictive of Chinese compound awareness (23% of the variance) after controlling for non-verbal abilities and English phonological awareness. Similarly, Chinese compound awareness uniquely predicted English compound awareness (14% of the variance). Consistent with previous research (Wang et al., 2006; Zhang, 2012), these findings supported cross-linguistic transfer of compound awareness between Chinese and English, and showed that a heightened sensitivity to compound structures of word formation in one language leads to better sensitivity of compound structures in the other language under acquisition. Furthering the investigation of these cross-linguistic relationships, the present study also tested cross-linguistic cross-modal effects of phonological awareness and compound awareness on word-level reading and oral vocabulary. These relationships are discussed below.
Cross-linguistic effects of compound awareness on word-level reading.

The findings regarding transfer of morphological awareness to word-level reading showed that compound awareness did not have direct or indirect cross-linguistic effects on either concurrent or longitudinal word-level reading between Chinese and English after general abilities, phonological awareness in both languages as well as oral vocabulary in the target language were all included in the model. These findings were partially supportive of studies conducted by Wang and colleagues (2006, 2009). On the one hand, the current study, together with those by Wang et al. (2006, 2009), suggests that no cross-linguistic transfer was found from Chinese compound awareness to English word reading. The finding was not surprising given that the most dominant method of word formation in English is derivation and inflection, rather than compounding (see detailed discussion in Chapter 2). On the other hand, the findings of a lack of cross-linguistic transfer from English compound awareness to Chinese character reading in the current study seem to be inconsistent with previous research conducted by Wang et al. (2009). Their findings, based on Chinese-English bilingual children of similar ages, suggested that English compound awareness accounted for unique variance in Chinese character reading after other Chinese (i.e., oral vocabulary, onset awareness, compound awareness, orthographic processing) and English measures (i.e., phonemic awareness and orthographic processing) were statistically controlled in the regression model. Nevertheless, the results of this current study were consistent with another study conducted by Wang et al. (2006), which showed that English compound awareness did not significantly contribute to Chinese character reading after partialling out the effects of general abilities, and relevant Chinese measures (i.e., oral vocabulary, rime awareness and onset awareness), and English phonemic awareness. The discrepancy in cross-linguistic effects of English compound awareness on Chinese character
reading may be attributed to the fact that different measures were controlled in each testing. When a comprehensive Chinese phonological measure was controlled as in Wang et al. (2006; i.e., both Chinese onset and rime awareness were included) and this current study (i.e., the Chinese phonological awareness measure tapped into syllable, onset and rime awareness), no cross-linguistic transfer was found from English compound awareness to Chinese character reading, suggesting shared variance between phonological and morphological measures.

**Cross-linguistic effects of compound awareness on oral vocabulary.**

The current study found that compound awareness had no direct (or unique) cross-linguistic effects on oral vocabulary between Chinese and English. This finding of no direct cross-linguistic effects of Chinese compound awareness on English oral vocabulary was consistent with the findings of McBride-Chang et al. (2006). In their investigation of biliteracy development among kindergarten children, McBride-Chang et al. examined the unique cross-linguistic contribution of Chinese compound awareness to English oral vocabulary after controlling for general abilities, Chinese character reading, and English and Chinese phonological awareness. Similarly, their results showed that Chinese compound awareness did not cross-linguistically transfer to the acquisition of English oral vocabulary.

Our finding of no direct cross-linguistic effect of English compound awareness on Chinese oral vocabulary seemed to be inconsistent with another study that reported a unique and bidirectional prediction between English compound awareness and Chinese oral vocabulary (Pasquarella et al., 2011). Such inconsistency was likely due to two reasons. First, the study by Pasquarella et al. was based on older children with a wide age range from Grades 1 to 4. With an increase in age, children may rely more on morphological strategy in vocabulary acquisition (e.g., Carlisle, 2000; Nagy et al., 2003); as a result, morphological awareness may play a more
important cross-linguistic role in oral vocabulary for bilingual children of older ages as suggested by the direct cross-linguistic contribution found by Pasquarella et al. (2011). Second, the current study adopted a more stringent test in which both English and Chinese phonological awareness were controlled; whereas Pasquarella et al. only included English phonological awareness as part of the control variables in their model.

Nevertheless, the current study suggests that there was indirect cross-linguistic association between compound awareness and oral vocabulary, which was completely mediated through the parallel morphological construct in the target language. Specifically, Chinese compound awareness indirectly contributed to English oral vocabulary through English compound awareness, and at the same time, English compound awareness indirectly contributed to Chinese oral vocabulary through Chinese compound awareness. Although these results would not be considered empirical evidence of cross-linguistic transfer of compound awareness to vocabulary, they still suggested some cross-linguistic associations between the two in biliteracy development of Chinese and English. It was the shared resources between Chinese and English compound awareness that contributed to acquisition of oral vocabulary in both Chinese and English.

**Comparison between cross-linguistic cross-modal effects of phonological awareness and those of compound awareness.**

The novelty of the current study lies in the design of a direct comparison of cross-language effects of phonological awareness and component awareness on word-level reading and oral vocabulary for Chinese-English bilingual children. Indeed, comparing the results of the two component skills yielded three important findings. Firstly, the current study indicated that phonological awareness made a direct cross-linguistic contribution to word-level reading among
Chinese-English bilingual children, a clear demonstration of cross-linguistic cross-modal transfer of phonological awareness to literacy between the two typologically distant languages. In contrast, the current study suggested no direct cross-linguistic prediction of morphological awareness for either word-level reading or oral vocabulary, and therefore, a lack of cross-linguistic cross-modal transfer of compound awareness to literacy between Chinese and English. Cross-linguistic transfer of phonological awareness to word-level reading between Chinese and English has been also consistently reported in other studies (e.g., Gottardo et al., 2006; Keung & Ho, 2009; M. Wang et al., 2009). These converging findings suggest that phonological awareness is a strong cross-linguistic predictor of word-level reading in biliteracy development of Chinese and English. On the other hand, cross-linguistic cross-modal transfer of morphological awareness to literacy between Chinese and English has been only weakly documented, in that when comprehensive phonological awareness measures in both English and Chinese are included in the models of investigation, there has often been a lack of direct (or unique) cross-linguistic contribution of morphological awareness to literacy outcomes (e.g., McBride-Chang et al., 2006; M. Wang et al., 2006). These findings seem to suggest that morphological awareness shared a large amount of variance with phonological awareness, and it is at most a very weak unique cross-linguistic predictor for literacy among Chinese-English bilingual children after the effect of phonological awareness is taken into consideration. Nonetheless, the study did find significant paths between Chinese and English phonological awareness and between Chinese and English compound awareness after controlling for general abilities and other relevant measures. These findings suggested cross-linguistic transfer between the parallel phonological and morphological constructs in the two languages.
Secondly, this study indicated that phonological awareness had more cross-language effects on concurrent and subsequent word-level reading (as suggested by both direct and indirect effects) than on oral vocabulary, while compound awareness was cross-linguistically more important for oral vocabulary (as suggested by indirect effects) than word-level reading. These findings revealed specificity in cross-linguistic cross-modal transfer as different component skills may have differentiated cross-linguistic effects on different literacy outcomes. To a large extent, such specificity is determined by the cognitive or metalinguistic demands of developing a specific literacy skill. The within-language relationship suggested by Study 1 of the current research has already suggested that word reading is more demanding on manipulation of sound structures, whereas developing oral vocabulary is more dependent on manipulation of meaning units. These within-language relationships may extend to further affect cross-linguistic relationships.

Thirdly, the directions of cross-linguistic cross-modal association were different for the two component skills. With regard to phonological awareness, both direct and indirect cross-linguistic cross-modal relationships were found between Chinese phonological awareness and English word reading, but not between English phonological awareness and Chinese character reading. With regard to compound awareness, an indirect cross-linguistic cross-modal association was found between Chinese compound awareness and English oral vocabulary, as well as English compound awareness and Chinese oral vocabulary. The differences in the directions of cross-linguistic associations for the two components once again suggest that the direction of cross-linguistic associations is not solely dependent on proficiency level of the two languages under acquisition for bilingual children (as proposed by Deacon et al., 2007, that transfer occurs from a more proficient language to a less proficient language), but a combination
of different factors. One factor is the essential within-language relationship between the component skill and the literacy outcome. Cross-linguistic cross-modal association between a component skill and a literacy skill may be more likely to occur when the development of this literacy skill also makes demands on the component skills within the target language. For example, the current study found that morphological awareness was a unique predictor of oral vocabulary within both Chinese and English, through which an indirect cross-linguistic association between morphological awareness and oral vocabulary was established between the two languages. Another factor concerns linguistic contexts or experiences. For example, an English dominant environment has shaped cognitive/metalinguistic correlates of Chinese reading acquisition, in that Chinese phonological awareness was not predictive of Chinese character reading abilities (as reported in other studies on Chinese-English bilingual children in North America; e.g., Gottardo et al., 2001), a relationship often reported for Chinese-English bilingual children in a Chinese dominant environment (e.g., Chow et al., 2005; Ho & Bryant, 1997a). As a result, English phonological awareness is not as likely to be cross-linguistically associated with Chinese character reading, either.
CHAPTER 8. GENERAL DISCUSSION AND CONCLUSION

The present thesis examined metalinguistic contributors to concurrent and subsequent word-level reading and oral vocabulary among Chinese-English bilingual children who learned Chinese as their heritage language and English as their societal language. While previous studies have mostly focused on one of the two languages in investigating biliteracy development, this thesis gave equal emphasis to both languages. The research had two general purposes: 1) to investigate independent within-language predictions of phonological awareness, morphological awareness and orthographic processing to concurrent and subsequent word-level reading and oral vocabulary in Chinese and English; and 2) to examine concurrent and longitudinal cross-linguistic predictions of phonological and morphological awareness to the two literacy outcomes.

To summarise the results, within-language relationships found in Study 1 indicated that phonological awareness, morphological awareness, and orthographic processing were all independent predictors of English word reading, whereas only morphological awareness predicted Chinese character reading. For both languages, morphological awareness was the only predictor of oral vocabulary. The longitudinal contributions of these metalinguistic skills to literacy outcomes were mostly mediated through auto-regressive effects of literacy skills. With respect to cross-linguistic relationships, Study 2 demonstrated that Chinese phonological awareness directly and indirectly predicted concurrent and subsequent English word reading though concurrent English phonological awareness, even after controlling for the influence of morphological awareness in both languages. Chinese morphological awareness indirectly contributed to concurrent and subsequent English oral vocabulary through concurrent English morphological awareness, after controlling for phonological awareness in both languages;
meanwhile, English morphological awareness was also indirectly predictive of concurrent and subsequent Chinese oral vocabulary through concurrent Chinese morphological awareness. Taken together, these findings suggest that Chinese and English impose different metalinguistic demands for literacy development. Moreover, metalinguistic skills transfer to literacy, even across the two typologically distant languages, yet the transfer patterns of phonological and morphological awareness to different literacy skills vary considerably. Individual results have been considered in detail in the discussion sections of the previous two chapters. In the current chapter, I focus on the theoretical and practical implications of the findings, the limitations of this research, and suggestions for future directions.

**Study One**

The findings of the within-language predictions of phonological awareness, morphological awareness and orthographic processing to word-level reading and oral vocabulary showed both similar and dissimilar patterns between Chinese and English. The differences mostly lie in the contributions of the three component skills to word-level reading in the two languages. While all three component skills independently predicted word reading in English, only morphological awareness predicted reading in Chinese. The lack of prediction from phonological awareness to Chinese character reading seems to challenge the universal view about the role of this construct in word-level reading (e.g., McBride-Chang & Kail, 2002; Ziegler & Goswami, 2005). Phonological awareness has been reported to be a unique predictor of word-level reading in alphabetic languages such as English (e.g., Wagner & Torgesen, 1987), and other alphabetic languages (e.g., French, Italian, and Spanish Casalis & Louis-Alexandre, 2000; Cossu et al., 1988; Denton, Hasbrouck, Weaver, & Riccio, 2000) and non-alphabetic languages (e.g., Chinese; Ho & Bryant, 1997a). Therefore, the importance of phonological awareness for
early reading abilities has been considered to be universal across languages or even contexts. Nevertheless, the findings of the current study suggest that learning to read Chinese characters in an English dominant environment may rely less on phonological awareness.

The lack of contribution from phonological awareness to Chinese reading may also be attributed to the effect of language and writing system constraints. On the one hand, the current study, together with previous research on Chinese children in a Chinese dominant environment (e.g., McBride-Chang, Cho, et al., 2005; Tong & McBride-Chang, 2010), jointly demonstrate that morphological awareness plays a more important role in Chinese reading than does phonological awareness. On the other hand, a similar analysis of English reading in the current study indicates that phonological awareness explained a much larger share of the independent variance (18%) in English word reading than morphological awareness (3%). Such differences between Chinese and English can be interpreted within ‘the script dependent hypothesis’, a theory proposed to conceptualize acquisition of reading skills across orthographies (Geva & Siegel, 2000, p. 2). In essence, ‘the script dependent hypothesis’ predicts that literacy acquisition varies across orthographies as a function of different constraints imposed by different mappings between oral languages and writing systems (Geva & Siegel, 2000; Perfetti & Cao, in press). English is an alphabetic language, and English orthography decodes the phonology of the oral language at the finest level. In English, the smallest orthographic units (i.e., letters) map onto the smallest phonological units (i.e., phonemes). Chinese orthography is logographic in nature and lacks such grapheme-phoneme mapping at a phonemic level, but instead, is more consistently associated with morphemes in the spoken language. The findings of differentiated predictions of phonological awareness and morphological awareness to reading in English and Chinese exactly reflected such writing system constraints.
Besides the influence of writing system constraints in English and Chinese, the dissimilar predictive patterns of phonological awareness, morphological awareness, and orthographic processing to word-level reading and oral vocabulary in Chinese and English may also be due to the effect of linguistic contexts. This research focused on Chinese-English bilingual children of immigrant families in Canada, who learned Chinese as a home language but were immersed in English at school or as a societal language. Through learning a language with a more complex phonological structure like English (see detailed discussion in Chapter 1), the bilingual children may have developed more advanced Chinese phonological awareness in comparison to Chinese monolingual children (as empirically shown by Marinova-Todd et al., 2010). As such, these children’s level of phonological awareness is more than sufficient for learning to read Chinese, and phonological awareness, therefore, may be a necessary, but not sufficient, factor in Chinese reading acquisition among Chinese-English bilingual children in an English dominant environment.

The Chinese print exposure that Chinese-English bilingual children in Canada have is limited, even though they were acquiring Chinese oral language skills through a home environment. Consequently, these bilingual children were yet to develop sufficient orthographic processing skills. In fact, in Study 1, the participants only received an average score of 13 out of 24 for the Chinese orthographic processing measure and their performance was significantly, but only slightly, above the guessing rate of .50 ($p < .05$). Using the same Chinese orthographic processing task, Luo et al. (2011) compared the development of orthographic processing between Chinese-English bilingual children in Canada and monolingual Chinese children in China. It was found that a Chinese dominant environment promoted the development of Chinese orthographic knowledge while children in an English dominant context only possessed very preliminary
knowledge regarding Chinese orthographical rules. Therefore, the limited Chinese orthographic
knowledge captured in Study 1 for bilingual children may not have reached the threshold for
Chinese reading. By contrast, our findings regarding English word reading were remarkably
similar to those of monolingual English-speaking children (Deacon, in press). This suggests that,
regardless of the status of being monolingual or bilingual, learning to read English words in an
English dominant environment demands these three interrelated underlying metalinguistic skills.

In addition to the above discussed between-language differences, my findings also
suggested some similarities. One key finding was that, in both Chinese and English,
morphological awareness was a stronger predictor of oral vocabulary than of word-level reading.
The importance of morphological awareness in acquiring reading skills and vocabulary
knowledge has been reported for monolingual children learning English (Deacon & Kirby, 2004;
McBride-Chang, Wagner, et al., 2005; Nagy et al., 2006) and Chinese (McBride-Chang, Cho, et
al., 2005; Shu et al., 2006). The findings of Study 1 further indicated that, among Chinese-
English bilingual children at initial stage of reading acquisition, abilities to manipulate
morphological structures and access morphological information are essential for acquiring oral
vocabulary in both languages, and its effect on vocabulary acquisition seems to be more
pronounced than its effect on word-level reading acquisition.

Study Two

The findings regarding cross-language effects of phonological awareness and
morphological awareness on word-level reading and oral vocabulary in Chinese-English
bilinguals confirmed the current theorization of language transfer in L2 research (Cummins,
1979; Genesee et al., 2006; Koda, 2008). Linguistic resources established in L1 can be accessible
and beneficial for acquisition of literacy skills in L2, or vice versa, even if the two languages
under acquisition are typologically dissimilar, such as Chinese and English. Consistent with previous studies (e.g., Gottardo et al., 2001; M. Wang et al., 2006), these results showed cross-linguistic transfer between parallel constructs in Chinese and English for both phonological awareness and morphological awareness. Most importantly, by comparing the independent cross-linguistic cross-modal effects of phonological awareness and morphological awareness on word reading and oral vocabulary in Chinese-English bilingual children, the current thesis found that phonological awareness was cross-linguistically more important to word reading, whereas morphological awareness had stronger cross-linguistic effects on oral vocabulary. The results, by extending the existing literature (e.g., Gottardo et al., 2006; M. Wang et al., 2006, 2006), further suggest that different component skills may have differentiated cross-linguistic impact on different literacy outcomes. Therefore, it is meaningful to identify specific cross-linguistic paths (towards specific literacy skills) in the conceptualization and empirical testing of transfer of any given component skill.

The findings of the current thesis also highlight the importance of examining and modeling within-language relationships when testing cross-language effects of a certain skill on literacy outcomes. One finding of Study 2 was that Chinese phonological awareness transferred to English word reading, but English phonological awareness did not transfer to Chinese character reading. In other words, cross-linguistic cross-modal transfer of phonological awareness to word-level reading was from Chinese to English but not English to Chinese among Chinese-English bilingual children. This result supports a similar unidirectional transfer of phonological awareness to word-level reading based on Chinese-English bilingual children in North America (e.g., Gottardo et al., 2001, 2006; M. Wang et al., 2005, 2009). Nevertheless, there was no clear explanation for such one-way cross-language effects. Through modeling the
within-language relationships, Study 2 revealed that the lack of cross-linguistic effects from English phonological awareness to Chinese reading was due to the missing relationship between phonological awareness and reading even within the Chinese language. In other words, English phonological awareness was not cross-linguistically important to Chinese reading because Chinese reading was less cognitively demanding on the ability to manipulate sound structure. Such unidirectional transfer differs from that reported for Chinese children in a Chinese dominant environment (Chow et al., 2005; Gottardo et al., 2001; Pan et al., 2011), which showed either bidirectional transfer between Chinese and English or unidirectional transfer from English to Chinese. Such discrepancies across studies may be attributed to the effect of linguistic contexts. To pinpoint why there are between-study differences, the technique of modeling within-language relationships may also be helpful for future investigations.

**Limitations and Future Directions**

This thesis has several limitations that need to be addressed in further research. First, biliteracy development was examined among children who had just started acquiring reading abilities, and therefore, the within- and between-language patterns reported in this study may be developmentally defined. In other words, older bilingual children or children with more advanced literacy skills may demonstrate different patterns. Research has demonstrated that oral vocabulary is more closely related to word reading as age or level of literacy skills increases (Hoover & Gough, 1990; Vellutino, Tunmer, Jaccard, & Chen, 2007). The contribution of component skills to word reading and vocabulary knowledge may also vary developmentally. Therefore, further research needs to investigate the within- and cross-language associations in different age groups to explore developmental change.
Another limitation concerns the reliability of a couple of measures used in the studies. The Chinese orthographic processing task had very low reliability. One possible reason is that young Chinese-English bilingual children in an English dominant environment have yet to develop sufficient stable knowledge to judge the spelling legality based on print rules in Chinese. On the other hand, the low reliability indicates the measure was not sensitive enough to capture beginning readers’ understanding of Chinese print rules. In addition, the multiple-choice testing format may have encouraged guessing in children’s responses. Therefore, in future studies, researchers need to develop a reliable Chinese orthographic measure for Chinese-English bilingual children with limited Chinese print exposure. Another task with relatively low reliability was the English oral vocabulary measure. The measure was adapted from the Peabody Picture Vocabulary Test-III A (PPVT-III A; Dunn & Dunn, 1997) by selecting 1/3 of the original items. The process may have affected the sample reliabilities, as Cronbach’s alpha for the original task is above .90 for a monolingual population (as reported in the manual; Dunn & Dunn, 1997), and as well as for bilingual samples (e.g., McBride-Chang et al., 2006).

Yet another limitation is that the current study had a relatively small sample size for path analyses investigating multivariate relationships. To have confidence in the goodness of fit test, a sample size of 100 to 200 is recommended (Hoyle, 1995) even though a sample as small as 50 participants could be acceptable (Bentler & Yuan, 1999). A model, in general, should contain 10 to 20 times as many observations as variables (Mitchell, 1993), and ratio of sample size to the number of free parameters should be as least 5:1 (Bentler, 1989). The current research marginally met these requirements in that the sample size approached 100. The ratio of observations to variables in the final model was over 11 for Study 1, and 13 for Study 2. The ratio of sample size to the number of free parameters was over 5 for the current research. Based on power analysis
using testing of alternative fit indices (MacCallum, 1996), the models converged in the current study had statistical power larger than .92 at $\alpha = .05$ to achieve GFI = .95 over .85. Nevertheless, the reported relationships should be replicated and confirmed with a larger sample size or cross-validated with another sample from a similar linguistic background to confirm the estimation.

Last but not least, the cross-language transfer of phonological awareness and morphological awareness to word-level reading and oral vocabulary was tested based on correlations. The general problem with this approach lies in the difficulty of disentangling the skills exclusively developed in L1 and those in L2. As Koda (2008) pointed out, cross-language transfer in biliteracy development is an ever-changing and dynamic process. It could well be that the skills captured in L1 and L2 are contaminated in such a dynamic relationship. The correlational approach by itself can hardly tease apart the proportion of skills developed only in L1 without the influence of L2, or vice versa. Future studies may consider two alternative methods to tackle this issue. The first method is to establish causality through intervention. The existing intervention studies have mostly examined the cross-linguistic relationships between parallel skills in the two languages under acquisition (e.g., the relationship between Chinese and English component awareness reported in Zhang et al., 2010), but have rarely looked into the extended cross-language effects of this skill on literacy outcomes. It would be worthwhile to adopt an intervention design in replicating the differentiated cross-language effects of phonological awareness and morphological awareness on word reading and oral vocabulary reported in the current thesis. The other method is cross-lag modelling, a technique involving measures of interest at multiple longitudinal points ($\geq$3). This method allows for an examination of cross-measure and cross-time relationships, so as to capture the dynamic and ever-changing cross-linguistic relationships between component skills and literacy across languages. Despite
the limitations, the current thesis has provided important results to inform theories and educational practice of early biliteracy development from a cognitive/metalinguistic perspective, which will be elaborated in the following sections.

Implications for Theories and Educational Practice

Implications for Theories

The current research informs theories of early biliteracy development. There are theoretical models explaining reading as an interactive process of sound, meaning and print (Plaut et al., 1996; Seidenberg & McClelland, 1989). The findings of this thesis suggest that the extent to which word-level reading is dependent on phonological, morphological and orthographic domains of processing in different languages varies as a result of the characteristics of language and writing systems under acquisition. In parallel with the evidence in monolingual English reading in which monolingual English children relied on all three processes in their early acquisition of word reading abilities (e.g., Deacon, in press), I found that bilingual children whose first language is not English were also able to draw upon these multiple underlying processing skills when learning to read English words at a very early stage. That is, phonological awareness, morphological awareness, and orthographic processing each uniquely predicted word-level reading in English after the effects of the other two on word-level reading and the interrelationships among them were controlled. In contrast, the current study shows that phonological awareness was apparently not as strong a predictor of Chinese word-level reading as it was for English word-level reading. Therefore, an interpretation of interactive processing of sound, meaning and print in a reading model would not be accurate without considering language and writing system constraints. Moreover, the findings regarding cross-language effects of phonological awareness and morphological awareness on word-level reading and oral
vocabulary in Chinese-English provided support for theories of transfer in literacy development among bilingual children (Cummins, 1979; Genesee et al., 2006; Koda, 2008), and at the same time further suggested the need for considering the dynamic process of transfer depending on language proficiency, linguistic environment and direction of transfer between the two languages under acquisition.

**Implications for Educational Practice**

Findings that emerged from the current research, on the one hand, indicated that early biliteracy acquisition of Chinese and English imposes different demands on phonological awareness, morphological awareness and orthographic processing among Chinese-English bilingual children. On the other hand, they suggest that, for Chinese-English bilingual children in an English dominant environment, phonological awareness developed in Chinese facilitates word reading in English, and that morphological awareness developed in one language may cross-linguistically facilitate vocabulary acquisition in the other. These findings have important implications for bilingual education in general and Chinese-English bilingual education in particular.

**Implications for English language education.**

The findings regarding the predictions of phonological awareness, morphological awareness and orthographic processing for word reading and oral vocabulary in English for this group of Chinese-English bilingual children are similar to monolingual English counterparts (Deacon, in press). Specifically, all three component skills are important for acquiring early word reading skills in English, whereas morphological awareness is particularly important for oral vocabulary acquisition in English. Therefore, effective literacy instruction for monolingual English-speaking children may also be effective for bilingual children. Intervention studies have
already suggested that the development of metalinguistic skills would benefit from explicit training (e.g., Bus & van Ijzendoorn, 1999). Separate intervention studies have shown that explicit training on phonological awareness, morphological awareness or orthographic processing promotes literacy acquisition (e.g., Arnbak & Elbro, 2000; Bus & van Ijzendoorn, 1999; Greaney, Tunmer, & Chapman, 1997). Given the distinctive role of phonological awareness, morphological awareness and orthographic processing in reading, it would be beneficial to explicitly and systematically teach children the three components skills so as to support early acquisition of word reading and oral vocabulary in English. Intentionally drawing children’s attention to the sound, meaning and print structures of the English language tackles distinctive aspects of literacy learning, and promotes children’s insights into oral language and its corresponding written forms. Such an approach would enable children to reflect on the language and hence advance their literacy development.

Additionally, English language educators should also gain knowledge about children’s first language background, and understand what skills may have been well developed in children’s first language and what skills may be missing and hence require special attention. For instance, the present findings suggest that phonological awareness and certain aspects of morphological awareness (i.e., compound awareness) in Chinese can cross-linguistically transfer to the learning of English. Therefore, educators should be confident about the skills that can transfer across Chinese and English, and instead, focus their instruction on skills from other areas where transfer is not likely to happen, such as orthographic processing, a skill repetitively reported as non-transferrable between Chinese and English (Gottardo et al., 2001; M. Wang et al., 2009). Since phonological awareness and compound awareness transfer across Chinese and
English, they can be considered as at-risk indicators for reading disabilities, and worth further assessment and diagnosis.

**Implications for Chinese heritage language education.**

Regarding Chinese literacy development, the current research showed that morphological awareness, but not phonological awareness or orthographic processing, was predictive of Chinese character reading for young Chinese-English bilingual children in an English dominant environment. The findings emerging from learners in an English dominant environment are different from those in a Chinese dominant linguistic context in which phonological awareness and orthographic processing were also found to play important role in character reading (e.g., Siok & Fletcher, 2001; Tong & McBride-Chang, 2010). Chinese heritage language educators should consider these cross-context discrepancies in their Chinese heritage language instruction. Specifically, morphological awareness was found to be the only unique predictor of both reading and vocabulary in Chinese, indicating that analytical instruction on meaning units of spoken Chinese, in particular the rules of compound morphemes to form new meanings, may be beneficial in literacy instruction for this group of children. It also should be noted that these young bilingual children may have had very limited print exposure to Chinese, and lack the basic knowledge regarding orthographic rules (Luo et al., 2011). Thus, for Chinese-English bilingual children in an English environment, literacy instruction may benefit from more emphasis on the morphological structure of oral Chinese and orthographic rules of Chinese writing. Nevertheless, whether or not explicit training on these aspects would directly increase children’s Chinese character reading abilities needs further exploration with an intervention design.

The evidence of cross-linguistic transfer of Chinese phonological awareness and morphological awareness to word-level reading and/or oral vocabulary in English should also
lend more confidence to heritage language educators and Chinese parents to continue supporting literacy development in Chinese among these bilingual children. These metalinguistic skills, developed in their first language, can be readily used in acquiring two fundamental literacy skills in English. The bilingual children of this study demonstrated well developed English reading abilities, and even performed way above the standard norm based on monolingual English children (i.e., the averages of their standardized scores for English word reading was 116 at Time 1 and 119 at Time 2). Therefore, learning of Chinese would not jeopardize, and may in fact facilitate, the development of English literacy skills necessary for functioning and thriving in an environment where English is the societal language.
REFERENCES


Appendix A. Family Language Questionnaire

Dear Parents: Thank you for allowing your child to participate in our study. Please take a few minutes to fill out this questionnaire, as it will greatly assist our research. All the information provided by you will be kept confidential and will NOT be released without your permission. This questionnaire can be returned to the Chinese classroom teacher.

1. The name of the child is ______________________, born on ____________________

2. Gender: M ____ F ____

3. Child’s country of birth: __________ If the child was NOT born in Canada, how old was the child when he/she moved to Canada? ______________

4. In what grade is your child currently enrolled in the public school? Grade ______
   In what grade is your child currently enrolled in the Chinese school? Grade ______
   Approximately, how many hours per week does your child attend the Chinese class ______________

5. What is your native language(s)? ___________ What is your native country? ________
   If you were not born in Canada, at what age did you move to Canada? ______________
   How many years have you lived in Canada? ______________

6. What is your partner’s native language(s)? ________ What is his/her native country? ________
   If he/she was not born in Canada, at what age did he/she move to Canada? ______________
   How many years has he/she lived in Canada? ______________

7. Your relationship to the child:
   □ Mother □ Grandparent
   □ Father □ Other (please specify) __________

8. Your highest education level (completed):
   □ Primary school graduate □ College diploma
   □ Junior high school graduate □ University degree
   □ High school graduate □ Graduate degree (Master’s or Ph.D.)

9. Your spouse’s education level / Parent’s education level:
   □ Primary school graduate □ College diploma
   □ Junior high school graduate □ University degree
   □ High school graduate □ Graduate degree (Master’s or Ph.D.)

10. Which of the following ranges represents your household income?
    □ $25,000以上 □ $51,000 to $75,000
    □ $26,000 to $50,000 □ $76,000以上

11. What is your occupation?______________ What is your spouse’s occupation______________
12. For each of the following language skills, rate how well you think **YOU** can perform on that skill. *(Circle one number per language per skill)*

<table>
<thead>
<tr>
<th>Language</th>
<th>none</th>
<th>intermediate</th>
<th>very good</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Understanding</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>English</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td><strong>Speaking</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>English</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td><strong>Reading</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>English</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td><strong>Writing</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>English</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

13. For each of the following language skills, rate how well you think **YOUR SPOUSE** can perform on that skill. *(Circle one number per language per skill)*

<table>
<thead>
<tr>
<th>Language</th>
<th>none</th>
<th>intermediate</th>
<th>very good</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Understanding</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>English</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td><strong>Speaking</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>English</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td><strong>Reading</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>English</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td><strong>Writing</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>English</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

14. How often does the **CHILD** use the following languages at home? *(Check all that applies.)*

<table>
<thead>
<tr>
<th>Language</th>
<th>Never 0</th>
<th>Rarely 25%</th>
<th>Sometimes 50%</th>
<th>Frequently 75%</th>
<th>Always 100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

15. How often do **YOUR FAMILY** speak the following languages TO the **CHILD**? *(Circle one number per skill)*

<table>
<thead>
<tr>
<th>Language</th>
<th>Never 0</th>
<th>Rarely 25%</th>
<th>Sometimes 50%</th>
<th>Frequently 75%</th>
<th>Always 100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Father</td>
<td>English</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chinese</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mother</td>
<td>English</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chinese</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

16. How often does your child who is participating in this study watch TV or videos in Chinese and in English?

<table>
<thead>
<tr>
<th>Language</th>
<th>Never</th>
<th>&lt; 2 hours / week</th>
<th>2-5 hours / week</th>
<th>1-2 hours / day</th>
<th>&gt; 2 hours / day</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
17. How often does your child read in English and in Chinese?

<table>
<thead>
<tr>
<th>Language</th>
<th>Never</th>
<th>&lt; 2 hours / week</th>
<th>2-5 hours / week</th>
<th>1-2 hours / day</th>
<th>&gt; 2 hours / day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chinese</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>English</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

18. Approximately how many children’s books do you have around the house (including library books) in Chinese and in English?

<table>
<thead>
<tr>
<th>Language</th>
<th>0</th>
<th>1-20</th>
<th>21-40</th>
<th>41-60</th>
<th>61-80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chinese</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>English</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The amount of time the child spends in the following activities after school (specify the number of hours)
Homework: _____; watching TV or videogames: _____; playing sports: ______; doing house chores: ______; using the Internet: _____; talking to you: ______ Others (please specify):
__________________________

Please list the usual things your child does during the weekend ____________________________
Appendix B. English Test of Derivational Morphology

Instruction and test items

“I want you to help me with a word game. I’m going to say a word and I want you to change it to fit the sentence. Let’s try one.”

1. Cat. I have two ____ . How could you change cat to fit that sentence? [cats]

*If they get that,* say, “Right. I have two cats.”

*If they miss the first one,* explain that they need to change it to fit the sentence (cat has to become cats) and repeat the complete sentence with the correct answer.

Give next examples in the same way.

2. Farm. My uncle is a ____ . How could you change farm to fit that sentence? [farmer]

3. Look. I found the kitten after I ____ . [looked]

“Ok. Do you have any questions? Great. Remember you just have to change the word to fit the sentence.”
<table>
<thead>
<tr>
<th>Time 1</th>
<th>Time 2</th>
<th>Word</th>
<th>Sentence</th>
<th>Response</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>jacket</td>
<td>Millie has three …</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>skip</td>
<td>Yesterday at recess, the girls …</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>music</td>
<td>That lady with the piano is a…</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>slow</td>
<td>I was glad that I wasn’t the …</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>science</td>
<td>I want to grow up to be a …</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>four</td>
<td>The horse came in …</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>6</td>
<td>dance</td>
<td>She is an excellent …</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>7</td>
<td>art</td>
<td>Harry’s mother is an …</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>8</td>
<td>cloud</td>
<td>I really hope that it’s not …</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>9</td>
<td>paint</td>
<td>Jane is a messy…</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>10</td>
<td>curl</td>
<td>His hair is very…</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>11</td>
<td>calm</td>
<td>The teacher asked us to walk…</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>12</td>
<td>magic</td>
<td>He was a very good…</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
<td>strong</td>
<td>He wanted to show off his …</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>13</td>
<td>discuss</td>
<td>Mum and Dad had a long boring…</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>14</td>
<td>appear</td>
<td>He cared about his …</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td></td>
<td>remark</td>
<td>The speed of the car was…</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>major</td>
<td>major</td>
<td>He won the vote by a …</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>humor</td>
<td>humor</td>
<td>The story was quite …</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>15</td>
<td>mystery</td>
<td>The dark glasses made the man look …</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>growth</td>
<td>growth</td>
<td>She wanted her plant to…</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time 1</td>
<td>Time 2</td>
<td>Word</td>
<td>Sentence</td>
<td>Response</td>
<td>Score</td>
</tr>
<tr>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-----------------------------------------------</td>
<td>----------</td>
<td>-------</td>
</tr>
<tr>
<td>17</td>
<td></td>
<td>chirp</td>
<td>The bird in the cage is…</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td></td>
<td>tooth</td>
<td>The dentist found cavities in some of Sam’s…</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td></td>
<td>description</td>
<td>The picture is hard to…</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td>snore</td>
<td>At naptime, the children are…</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td></td>
<td>shrink</td>
<td>After Mom washed the pants, they…</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td></td>
<td>miss</td>
<td>This is the letter that I am…</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td></td>
<td>eyebrow</td>
<td>She raised both her…</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td></td>
<td>sparkle</td>
<td>Last night, the lights…</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>cook</td>
<td>At dinnertime Mom is always…</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td></td>
<td>thaw</td>
<td>The frozen food on the counter is…</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td></td>
<td>break</td>
<td>When the dish fell on the floor, it…</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td></td>
<td>elf</td>
<td>The children dressed up as…</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix C. English Test of Compound Morphological Awareness

Instructions and Items

Instructions: “We are going to think about some objects. Some of them are daily objects that we see, and some are weird objects that we’ve never seen before. I want you to try to come up with names for those weird objects based on the names of the daily objects.”

Practice Items: “Let’s try a couple. You tell me what we should call the weird object.”

A. bug that bothers people in bed is called a bedbug.

What do we call a bug that bothers people on the sofa? (sofabug)

B. There is a centre where children are cared for during the day. We call it a childcare centre.

If there is a centre where pets are cared for during the day, what do we call it? (petcare centre)

Feedback: For practice items, examiner offers feedback. For correct items, examiner says “Good, that is what we would call the weird object.” For incorrect items, examiner says “That’s a good try. But, let’s call it (correct response) instead.”

Do not provide feedback on test items.

1. There is a team of dogs that pulls a sled and we call it a dogsled team.

Now there is a team of cats that pulls a sled, what do we call it? (catsled team)

2. A little house that is built in a tree is called a treehouse.
What do we call a house that is built in a shrub? *(shrubhouse)*

3. There is a dog that spends most times in the yard around a farm and we call it a *farmyard dog*.
   
   Now there is a mouse that spends time in the yard around a farm, what do we call it? *(farmyard mouse)*

4. Some fish are found deep in the sea. We call them *deep-sea fish*.
   
   If we found fish deep in the lake, what do we call them? *(deep-lake fish)*

5. Early in the morning, we can see the sun rising. This is called a *sunrise*.
   
   At night, we might also see the moon rising. What could we call this? *(moonrise)*

6. One type of worm that is about the length of an inch is called an *inchworm*.
   
   If there were a snake about the length of an inch, what could we call it? *(inchsnake)*

7. There is a kind of whale with a hump on its back. We call it a *humpback whale*.
   
   If there was a kind of whale with a hump on its head, what do we call it? *(humphead whale)*

8. There is a pill that is taken to help an ache that a person has in their head and we call it a *headache pill*. Now there is a pill to help an ache in a person’s toe, what do we call it? *(toeache pill)*

9. A boat that moves because of its sails is called a *sailboat*.
   
   What would we call a train that moved with sails? *(sailtrain)*
10. A toy that one needs to wind up to start, we call it a wind-up toy.

   If there is a bird that winds up to start, what do we call it? (wind-up bird)

11. Some buildings are built very high and we call them high-rise buildings.

   Some buildings are built very low, what do we call them? (low-rise buildings)

12. A board that is written on with chalk is called a chalkboard.

   If we wrote with chalk on a plate, what do we call it? (chalkplate)

13. There is an egg that is boiled to make it hard, we call a hard-boiled egg.

   If we baked an egg to make it hard, we would we call it? (hard-baked egg)

14. When beef is cooked by stirring and frying it in a pan, we call it stir fried beef.

   When stirring and frying nuts, what do we call it? (stir fried nuts)

15. The metal shoes that are put on horses are called horseshoes.

   If we put metal shoes on pigs, what do we call them? (pigshoes)
Appendix D. English Test of Orthographic Processing

Instructions and Items

Materials: Individual student score sheets

Directions: “In this activity, I am going to show you a non-word in English. This is not a real word; you won’t have heard it or seen it before. I want you to decide which of the two spellings would be the best way to spell the non-word in English. Remember, they are not spellings for real words in English, but they just need to look like they could be. If you don’t know the answer it’s okay to guess. I want you to point out the one that looks most like the English spelling for the non-word.”

Practice Items: “Let’s try a couple.”

<table>
<thead>
<tr>
<th>buice</th>
<th>booce</th>
</tr>
</thead>
<tbody>
<tr>
<td>keeph</td>
<td>keaf</td>
</tr>
<tr>
<td>heeks</td>
<td>heex</td>
</tr>
</tbody>
</table>

Feedback: Give feedback such as “Good. So in these you’re telling me that this one looks like it is probably the way to spell this in English.”

If child provides an incorrect answer, examiner responds with “That was a good try. Actually, the correct answer is this one.” (indicating the correct item).

Test Items: Proceed with test items 1-20 on individual scoring sheet. Be sure the child is aware that there are two pages to complete.

Scoring: Child independently indicates responses; examiner records responses.
<table>
<thead>
<tr>
<th>Item</th>
<th>Choice A</th>
<th>Choice B</th>
<th>Item</th>
<th>Choice A</th>
<th>Choice B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>teed</td>
<td>tede</td>
<td>11</td>
<td>bock</td>
<td>bawc</td>
</tr>
<tr>
<td>2</td>
<td>nool</td>
<td>newl</td>
<td>12</td>
<td>tade</td>
<td>teyd</td>
</tr>
<tr>
<td>3</td>
<td>pleu</td>
<td>plew</td>
<td>13</td>
<td>tewj</td>
<td>tuge</td>
</tr>
<tr>
<td>4</td>
<td>dage</td>
<td>daij</td>
<td>14</td>
<td>byve</td>
<td>bive</td>
</tr>
<tr>
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<td>vayk</td>
<td>15</td>
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<td>moez</td>
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<td>sife</td>
<td>16</td>
<td>lerm</td>
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<tr>
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<td>kail</td>
<td>kayl</td>
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<td>runc</td>
<td>runk</td>
</tr>
<tr>
<td>8</td>
<td>nepe</td>
<td>neep</td>
<td>18</td>
<td>heaf</td>
<td>hefe</td>
</tr>
<tr>
<td>9</td>
<td>fiem</td>
<td>fime</td>
<td>19</td>
<td>voep</td>
<td>vope</td>
</tr>
<tr>
<td>10</td>
<td>kewm</td>
<td>koom</td>
<td>20</td>
<td>nirm</td>
<td>nurn</td>
</tr>
</tbody>
</table>
## Appendix E. Chinese Test of Phonological Awareness

### Syllable Deletion 音节删除

主试说: “我现在说几个音，请你跟我说一次”。如果儿童说不出，请重复一次。在儿童能正确地说出这个音之后，继续说，“然后试着不说其中的一个音，看看还剩什么?”

例如：我说 火车 （让儿童跟着说 火车），现在不说火，还剩______ (车).

例如：我说 牙书鱼 （让儿童跟着说 牙书鱼），现在不说出书，还剩______ (牙鱼).

<table>
<thead>
<tr>
<th>序号</th>
<th>词语</th>
<th>不说哪个音</th>
<th>还剩哪个音</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>工作</td>
<td>不说出作</td>
<td>还剩 ______ (工)</td>
</tr>
<tr>
<td>2</td>
<td>下不更</td>
<td>不说出下</td>
<td>还剩 ______ (不更)</td>
</tr>
<tr>
<td>3</td>
<td>捶苦</td>
<td>不说出苦</td>
<td>还剩 ______ (捶)</td>
</tr>
<tr>
<td>4</td>
<td>悬士约</td>
<td>不说出约</td>
<td>还剩 ______ (悬士)</td>
</tr>
<tr>
<td>5</td>
<td>gi1 biang4 ten2</td>
<td>不说出 biang4</td>
<td>还剩 ______ (gi1 ten2)</td>
</tr>
<tr>
<td>6</td>
<td>面包</td>
<td>不说出面</td>
<td>还剩 ______ (包)</td>
</tr>
<tr>
<td>7</td>
<td>rei3 cin1 due4</td>
<td>不说出 due4</td>
<td>还剩 ______ (rei3 cin1)</td>
</tr>
<tr>
<td>8</td>
<td>麦当劳</td>
<td>不说出当</td>
<td>还剩 ______ (麦劳)</td>
</tr>
<tr>
<td>9</td>
<td>西红柿</td>
<td>不说出西</td>
<td>还剩 ______ (红柿)</td>
</tr>
<tr>
<td>10</td>
<td>fao3 biu2</td>
<td>不说出 biu2</td>
<td>还剩 ______ (fao3)</td>
</tr>
<tr>
<td>11</td>
<td>熏孔</td>
<td>不说出熏</td>
<td>还剩 ______ (孔)</td>
</tr>
<tr>
<td>12</td>
<td>kie4 pun1</td>
<td>不说出 kie4</td>
<td>还剩 ______ (pun1)</td>
</tr>
</tbody>
</table>
### Phoneme Deletion 音位删除

主试说: “我现在说几个音, 请你跟我说一次”。如果儿童说不出，请重复一次。在儿童能正确地说出这个音之后，继续说，“然后试着不说其中的一个音，看看还剩什么?”

例如: 我说 kan4 (看) (让儿童跟着说 kan4)，不说出 /k/，还剩_____; an4 (按)

例如: 我说 gin3 (顶) (让儿童跟着说 gin3)，不说出 /g/，还剩_____; (y)in3 (引)

| 13 | bie1 (憋), 不说出 /b/, 还剩_____; ye1 (噎) |
| 14 | fang2 (房), 不说出/f/, 还剩_____; ang2 (昂) |
| 15 | len1, 不说出 /l/, 还剩_____; en1 (恩) |
| 16 | duo3 (躲), 不说出/d/, 还剩_____; wo3 (我) |
| 17 | tou3, 不说出 /t/, 还剩_____; ou3 (藕) |
| 18 | ha1, 不说出/h/, 还剩_____; a1 (啊) |
| 19 | fai3, 不说出 /f/, 还剩_____; ai3 (矮) |
| 20 | se4 (色), 不说出 /s/, 还剩_____; e4 (饿) |
| 21 | mun2, 不说出/m/, 还剩_____; (w)un2 (文) |
| 22 | piao4 (票), 不说出 /p/, 还剩_____; yao4 (要) |
| 23 | zhuai4 (拽), 不说出 /zh/, 还剩_____; wai4 (外) |
| 24 | nui2, 不说出 /n/, 还剩_____; (w)ui2 (为) |
Appendix F. Chinese Test of Compound Morphological Awareness

Instructions and Items

此任务用来测试被试的语素意识，是一个听说任务。所以主试应当提醒被试仔细地听，然后作答。

“小朋友，我们现在来做一个游戏。你要仔细地听，认真的想，然后回答我的问题，好吗？我们先来做几个练习。”

（注意：在做练习的时候，当被试作答之后，测试者应该给出正确答案，但是不要详细解释选择的原因。在测试的时候，被试可能用多个语素回答，比如说，“长颈象”，被试说成“长颈大象”。此时请启发一次，说“你的回答很好，但是如果如果我们用三个字来起名字，我们怎么说呢？”

练习1：“如果有个盒子,是用来装饭的，我们就叫它 **饭盒**。如果有个袋子，是用来装饭的，我们就叫它什么？”[**饭袋**]

练习2：“好，我们再来举个例子，头很胖的鱼我们叫 **胖头鱼**，那么头很胖的鸭我们叫它什么？”[**胖头鸭**]

正式题目：

1. 有一种鹿，脖子很长，我们叫它 **长颈鹿**，那么有一种大象，脖子也很长，我们叫它什么？

   [**长颈象**]

2. 戴在手上的表我们叫 **手表**，那么戴在脚上的表我们可以叫它什么？[**脚表**]

3. 有一种鹰，头长得像猫，我们叫它 **猫头鹰**；那么另外一种鹰，头长得像狗，我们叫它什么？

   [**狗头鹰**]

4. 长在树上的叶子我们叫 **树叶**，那么长在树上的瓜我们叫它什么？[**树瓜**]

5. 往马路上洒清水的车我们叫 **洒水车**，往马路上洒鲜花的车我们叫什么？[**洒花车**]
6. 可以来用来插花的瓶子叫**花瓶**，那么可以用来插花的锅我们叫它什么？[花锅]

7. 有一种鸟，用嘴啄大树，给大树治病，我们叫**啄木鸟**，那么有一种虫，也用嘴啄大树，给大树治病，我们叫它什么？[啄木虫]

8. 放在台子上的灯我们叫**台灯**，放在椅子上的灯我们叫它什么？[椅灯]

9. 装在自行车前面用来放东西的小筐我们叫**车筐**，那么装在自行车前面用来放东西的小桶我们可以叫它什么？[车桶]

10. 有一种家用电器，可以用来把衣服洗干净，我们叫它**洗衣机**，那另外一种家用电器，可以用来把鞋子洗干净，我们叫它什么？[洗鞋机]

11. 有一种葵花，向着太阳生长，我们叫它**向日葵**，那么另外一种葵花，背着太阳生长，我们叫它什么？[背日葵]

12. 用动物的皮做的鞋我们叫**皮鞋**，用动物的毛做的鞋我们叫什么？[毛鞋]

13. 有一种炮，可以向高处发射炮弹，我们叫**高射炮**，那么另外一种炮，可以向低处发射炮弹，我们可以叫它什么？[低射炮]

14. 有一种橡皮圈，在水里遇到危险时用来救命，我们叫**救生圈**，那么有一种橡皮球，在水里遇到危险时也用来救命，我们叫它什么呢？[救生球]

15. 有一种车站，可以给车添加汽油，我们叫做**加油站**，那么另外一种车站，可以给车添加清水，我们叫它什么？[加水站]
Appendix G. Chinese Test of Orthographic Processing

Instructions and Items

此测验用来测试被试对中文的正字法意识。主试说，“小朋友，我们现在来做一个游戏。这个游戏分为两个小部分。 希望你（们）集中注意力按照我的要求来做。”

第一部分

“好，你（大家）做得很好。我们来看第二部分。第二部分共有 12 题，每题中有两个假的汉字。因为它们都不是真的，所以你绝对没有见过。在这两个假字中，有一个更像真字，而另外一个就不那么像真的。请你（们）仔细地看，然后用笔圈出那个更像真字的假字。好，我们来做两个练习。”

注意： 在做练习的时候，当被试作答之后，测试者应该给出正确答案，但是不要详细解释选择的原因。

第二部分

“嗯，大家做得真不错。我们来看看第三部分。第三部分有 12 题，每题中有两个假的汉字。因为它们都不是真的，所以你绝对没有见过。在这两个假字中，有一个更像真字，而另外一个就不那么像真的。请你们仔细地看，然后用笔圈出那个更像真字的假字。好，我们来做两个练习。”

注意： 在做练习的时候，当被试作答之后，测试者应该给出正确答案，但是不要详细解释选择的原因。